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**FIFTY-FOURTH ANNUAL REPORT**  
**OF THE**  
**NORTH CAROLINA**  
**AGRICULTURAL EXPERIMENT**  
**STATION**

**R. Y. WINTERS, Director**

**THE NORTH CAROLINA STATE COLLEGE**  
**OF AGRICULTURE AND ENGINEERING**

**AND**

**STATE DEPARTMENT OF AGRICULTURE**  
**COOPERATING**

**STATE COLLEGE STATION**  
**RALEIGH**



**FOR THE FISCAL YEAR ENDING JUNE 30, 1931**  
**PROGRESS REPORT FOR YEAR ENDING**  
**DECEMBER 1, 1931**

AMERICAN INDIAN  
UNIVERSITY

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**FOR THE FISCAL YEAR ENDING JUNE 30, 1931**  
**PROGRESS REPORT FOR YEAR ENDING**  
**DECEMBER 1, 1931**





## LETTERS OF SUBMITTAL

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STATE COLLEGE STATION,  
RALEIGH, N. C.

PRESIDENT C. C. BROOKS,

*North Carolina State College of Agriculture and Engineering,  
State College Station, Raleigh, N. C.*

DEAR SIR:

I have the honor to submit herewith the annual report of progress in agricultural research of the Agricultural Experiment Station of the North Carolina State College of Agriculture and Engineering and the North Carolina State Department of Agriculture. The report contains recommendations for strengthening research and a summary of results accomplished at the Central and Branch Stations during the fiscal year ending June 30, 1931.

Respectfully yours,

R. Y. WINTERS, *Director.*

---

COPY.

RALEIGH, N. C.

HONORABLE O. MAX GARDNER,

*Raleigh, North Carolina.*


MY DEAR GOVERNOR:

I take pleasure in transmitting to you the Fifty-fourth Annual Report of the North Carolina Agricultural Experiment Station. The report records the accomplishments of agricultural research for the year ending June 30, 1931.

The work of the past year has been conducted in accordance with the program approved by the Experiment Station Committee.

Very sincerely yours,

(Signed) E. C. BROOKS, *President.*



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**OFFICERS AND STAFF**  
OF THE  
**NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION**  
**JANUARY 1, 1932**

E. C. BROOKS	President of the College
I. O. SCHAUB	Dean of the School of Agriculture
R. Y. WINTERS	Director
C. B. WILLIAMS	Vice-Director
*F. E. MILLER	Director of Branch Stations
F. H. JETER	Agricultural Editor
A. F. BOWEN	Treasurer

**AGRICULTURAL ECONOMICS**

G. W. FORSTER	Economist
J. G. KNAPP	Associate in Marketing
R. H. ROGERS	Associate in Farm Management
W. B. GOODING	Assistant in Farm Management
G. R. SMITH	Assistant in Cotton Marketing in Cooperation with U. S. Department of Agriculture

**AGRONOMY**

C. B. WILLIAMS	Agronomist
L. G. WILLIS	Soil Chemist
J. R. PILAND	Assistant Chemist
H. B. MANN	Associate in Soil Fertility Investigations
W. H. RANKIN	Soil Fertility Investigations
W. A. DAVIS	Assistant in Soil Survey
E. F. GOLDSTON	Assistant in Soil Survey
S. O. PARKINS	Soil Survey, in Cooperation with U. S. Department of Agriculture
R. C. JOURNEY	Soil Survey, in Cooperation with U. S. Department of Agriculture
F. O. BARTEL	Senior Drainage Engineer, in Cooperation with U. S. Department of Agriculture
J. M. SNYDER	Soil Technologist, in Cooperation with U. S. Department of Agriculture
P. H. KIME	Associate in Plant Breeding
G. M. GARREN	Assistant in Plant Breeding
J. H. MOORE	Cotton Technologist
E. G. MOSS	In charge Tobacco Investigations for the State Department of Agriculture and U. S. Department of Agriculture
W. H. STUART, JR.	Assistant Agronomist, U. S. Department of Agriculture
R. E. STITT	Assistant Agronomist, U. S. Department of Agriculture
R. Y. WINTERS	Plant Breeder

\*Workers and Branch Stations under authority of the State Department of Agriculture co-operating with the Agricultural Experiment Station in research.

## ANIMAL INDUSTRY

R. H. RUFFNER.....	<i>Head, Animal Industry</i>
C. D. GRINNELL.....	<i>Dairy Investigator</i>
J. E. FOSTER.....	<i>Beef Cattle and Sheep Investigations</i>
E. H. HOSTETLER.....	<i>Beef Cattle, Sheep and Swine Investigations</i>
J. O. HALVERSON.....	<i>In charge Animal Nutrition</i>
F. W. SHERWOOD.....	<i>Associate in Animal Nutrition</i>
F. H. SMITH.....	<i>Assistant in Animal Nutrition</i>
L. I. CASE.....	<i>Agent in Animal Husbandry, U. S. Department of Agriculture</i>

## BOTANY

B. W. WELLS.....	<i>Botanist</i>
S. G. LEHMAN.....	<i>Plant Pathologist</i>
R. F. POOLE.....	<i>Plant Pathologist</i>

## HOME ECONOMICS

MYRA DEHAVEN WOODRUFF.....	<i>Associate in Home Economics</i>
----------------------------	------------------------------------

## HORTICULTURE

J. H. BEAUMONT.....	<i>Horticulturist</i>
M. E. GARDNER.....	<i>Associate Horticulturist</i>
ROBERT SCHMIDT.....	<i>Associate Horticulturist</i>
C. F. WILLIAMS.....	<i>Associate Horticulturist</i>

## POULTRY HUSBANDRY

R. S. DEARSTYNE.....	<i>Poultry Investigator and Pathologist</i>
R. E. GREAVES.....	<i>Poultry Investigator and Pathologist</i>

## ZOOLOGY AND ENTOMOLOGY

Z. P. METCALF.....	<i>Entomologist</i>
B. B. FULTON.....	<i>Associate Entomologist</i>

## CENTRAL STATION—Raleigh

F. E. MILLER.....	<i>Director of Branch Stations</i>
R. J. HARRIS.....	<i>Assistant Director in Charge</i>

## \*BRANCH STATIONS

### *Blackland Test Farm—Wenona*

J. L. REA, JR.....	<i>Assistant Director in Charge</i>
A. P. LEFEVERS.....	<i>Foreman</i>
BRYAN HARRIS.....	<i>Herdsmen</i>

### *Coastal Plain Test Farm—Willard*

CHAS. DEARING.....	<i>Assistant Director in Charge</i>
D. P. SOUTHERLAND.....	<i>Foreman</i>
T. H. CAMERON.....	<i>Dairy Herdsman</i>
C. O. BOLLINGER.....	<i>Poultryman</i>
W. H. STUART, JR.....	<i>Assistant Agronomist, U. S. Department of Agriculture</i>

*Mountain Test Farm—Swannanoa*

S. C. CLAPP..... *Assistant Director in Charge*  
W. M. WHISENHUNT..... *Foreman*  
H. B. COULTER..... *Dairy Herdsman*  
CLARENCE KEITH..... *Poultryman*

*Piedmont Test Farm—Statesville*

J. W. HENDRICKS..... *Assistant Director in Charge*  
R. E. STITT..... *Assistant Agronomist, U. S. Department of Agriculture*

*Tobacco Test Farm—Oxford*

E. G. MOSS..... *Assistant Director in Charge*  
JAMES F. BULLOCK..... *Assistant Tobacco Investigations, U. S.  
Department of Agriculture*  
A. B. DEAN..... *Foreman*

*Upper Coastal Plain Test Farm—Rocky Mount*

R. E. CURRIN, JR..... *Assistant Director in Charge*  
WM. ALLSBROOK..... *Herdsman*  
J. P. YOUNG..... *Assistant Tobacco Investigations, U. S.  
Department of Agriculture*

**EXPERIMENT STATION COMMITTEE**

D. J. LYBROOK, *Chairman*, Advance  
D. M. BUCK, Bald Mountain  
B. B. EVERETT, Palmyra  
J. S. WATKINS, Virgilina, Va., R. F. D.  
HARRY V. LATHAM, Belhaven  
DR. L. J. HERRING, Wilson  
W. A. BULLOCK, Red Springs





**FIFTY-FOURTH ANNUAL REPORT**  
**OF THE**  
**NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION**  
**FOR THE**  
**YEAR ENDING JUNE 30, 1931**

---

**INTRODUCTION**

The following pages contain a summary of accomplishments by the research staff in Agriculture. Members of the staff are aware of the unfavorable condition of agriculture and have continued their efforts to make available new and pertinent facts to those engaged in agricultural service and practice.

The work of the past year has been continued, with few exceptions, in the program which was revised in 1929. Eight projects were completed, four were discontinued because they were not yielding results, and six were revised.

**CHANGES IN STAFF**

Dr. B. F. Kaupp, head of the Poultry Department, resigned July 1, and was succeeded by R. S. Dearstyne, Associate in Poultry Research. R. E. Greaves, a graduate fellow, was appointed Assistant in Poultry Research, and H. P. Brigman as statistical clerk, beginning July 1.

**DIVISION OF PUBLICATIONS**

Much of the news matter issued by the Division of Publications deals with the results of research work done by members of the Agricultural Experiment staff. This material enjoys a wide distribution by the papers of the State because it supplies definite information founded on carefully prepared facts and figures.

The Division releases news articles each week through the local offices of the Associated Press, the United Press, the Association of Afternoon Dailies, and other correspondents. In addition, the weekly papers of the State are given a special service consisting of items based largely on informative material rather than timely news. Each of the principal daily papers of North Carolina now has a farm page in which feature articles signed by Experiment Station writers have a prominent place. These papers also hold some of the news releases sent to them through the press agencies and run these as a part of the farm page material. The whole helps to make up rather attractive pages which have attracted wide attention not only in North Carolina but in other states of the Nation.

The Division does not maintain large mailing lists to which the bulletins of the Station are mailed, but it does advertise each publication as issued and mails the publications in answer to the numerous requests received. New bulletins are also announced in the columns of the farm magazines and in other periodicals.

Timely articles from members of the Experiment Station staff are printed each month in Extension Farm News, house organ of the Extension

Service. This publication goes to all county agents, vocational teachers, county boards of agriculture and others interested in agricultural work. In this way the work of the Station is brought before readers that can make use of the information given.

### PUBLICATIONS

Four bulletins were published by the Experiment Station during the past fiscal year in an edition of 12,500 copies. The 53rd Annual Report, with an edition of 1,500 copies, was also edited and prepared for the printer. These publications received the careful attention of the assistant editor. In addition to these publications, six technical papers were read and edited for use by scientific journals.

The bulletins were also distributed through the regular mailing lists to directors and libraries of all experiment stations in the United States and eleven foreign countries and to subject matter workers of the various stations. This distribution added to the individual requests coming as a result of newspaper notices, were responsible for 11,500 copies being mailed from the publications office last year.

Requests from individual farmers, vocational teachers and research workers in other states for copies of former issues were received each day during the past year, and 43,984 bulletins were mailed in answer to these requests. Personal calls at the office by vocational teachers and county agents resulted in the distribution of 2,560 additional bulletins, making a grand total of 57,794 publications of the Experiment Station that were distributed.

In addition to the handling of these major publications, the office mimeographed or multigraphed 93,435 circular letters and distributed 19,650 of these to selected mailing lists. About 50,000 of the circulars were prepared for the Agronomy Department as Information Circulars, and were distributed from that office. Letterheads for the various offices, post cards, and envelopes have also been multigraphed in a total of 22,350 copies.

The Division of Publications also handled the printing of all report forms, statistical forms, and other matter classed as small printing. Prices were secured and the job followed through to completion, including delivery from printer. The assistant editor gave considerable time to conferring with heads of departments as to details in connection with their printing requirements during the past year.

The complete list of publications printed and distributed by the Experiment Station for the year ending June 30, 1931, is as follows:

<i>Number</i>	<i>Title</i>	<i>Number Issued</i>
<b>Popular Series:</b>		
276.	Cooperative Marketing Manual (Jos. G. Knapp)-----	3,500
277.	Planning the Farm Business (G. W. Forster)-----	3,000
<b>Technical Series:</b>		
39.	Investigations in the Feeding of Cottonseed Meal to Cattle (J. O. Halverson and F. W. Sherwood)-----	3,000
40.	Short Interval Testing as a Control of Pullorum Disease (Dearstyne-Greaves-Gauger)-----	3,000
<b>53rd Annual Report:</b> (R. Y. Winters)-----		1,500
Total-----		14,000

**Agronomy Information Circulars:**

52. Late Emergency Hay Crops, by S. J. Kirby and P. H. Kime.
53. Use of Commercial Fertilizer in the Growing of Cotton, by J. J. Skinner.
54. Preliminary Report on Three Years' Fertilizer Experiments with Early Irish Potatoes on the Farm of A. W. Baker, Aurora, Beaufort County, North Carolina—1928-30, by J. J. Skinner, C. B. Williams and H. B. Mann.
55. Some More Recent Lime Findings in Field Research Work in North Carolina, by C. B. Williams, H. B. Mann, and A. S. Cline.
56. Importance of Certain Factors, Particularly of Disease, in the Selection and Breeding of Corn, Including Some Historical Facts, by D. W. Bagley.
57. Results of Cotton Variety Experiments for 1927-30 and Production and Consumption of Different Staple Lengths, by P. H. Kime and S. J. Kirby.
58. Source and Care of Cotton Planting Seed on Some North Carolina Farms in Relation to Length of Staple Produced, by J. H. Moore and J. A. Shanklin.
59. Suggested Plan for Improving the Quality of Cotton in North Carolina, by R. Y. Winters.
60. Suitable Fertilizer Mixtures for Different Crops, Including the Function of Chief Plant Nutrients, by C. B. Williams and H. B. Mann.
61. Methods of Calculating Fertilizer Mixtures, by J. F. Lutz.

**Technical Papers:**

43. Free Ammonia Injury with Concentrated Fertilizers, by L. G. Willis and W. H. Rankin. Published in *Industrial and Engineering Chemistry*, December 1930, Vol. 22, p. 1405.
44. A Study of the Genus *Nemobius*, by B. B. Fulton. Published in *Annals of the American Entomological Society*, pp. 205-237, June 1931.
45. Powdery Mildew of Soybeans, by S. G. Lehman. Published in *Journal of the Elisha Mitchell Scientific Society*, Vol. 46, No. 2, pp. 190-195.
46. North Carolina Singing Orthoptera, by B. B. Fulton.
47. A Gynandromorph of *Megachile Latimanus*, by T. B. Mitchell. Published in *Journal of the Elisha Mitchell Scientific Society*, Vol. 47.
48. A Method for the Estimation of Free Gossypol Remaining in Cottonseed Meal, by J. O. Halverson and F. H. Smith.  
*Notes on Oregon Orthoptera with Descriptions of New Species and Races*, by B. B. Fulton. Published in *Annals of the Entomological Society of America* 23, pp. 611-641.  
*Cuban Fulgorina*. 1. The Families Tropituchidae and Acanaioniidae, by Z. P. Metcalf and S. C. Bruner. *Psyche* 37: 395-424: 5 plates.  
*Fulgoroidea*. Part 1. Tettigometridae. By Z. P. Metcalf. *General Catalog of the Hemiptera of the World Fascicle IV*. Part 1, pp. 1-70.

# RESEARCH IN AGRICULTURAL ECONOMICS

G. W. FORSTER, *Agricultural Economist*.

---

## INTRODUCTION

Investigations in agricultural economics for the year ending June 30, 1931, were conducted along the same general lines as outlined in last year's annual report. The only major change has been the addition of research in rural sociology. The investigations in this field will be expanded as rapidly as funds become available.

One project was completed during the year and the results published, Bulletin No. 277, "Planning the Farm Business," completed a series of farm management investigations started in 1925. The results published in this bulletin pertain to the conditions in the northeastern Coastal Plain. Bulletin No. 278, "Farm Accounts," was also published during the year. This bulletin grew out of the work in farm organization and management and was published to meet the needs of the farmers in preparing inventories of their farm business. The bulletin shows how inventories should be prepared and the general results which may be obtained from an analysis of the data contained in the inventories. In addition to these two bulletins, "A Cooperative Marketing Manual" was published. This manual contains information regarding cooperative associations, how they are organized and operated and also the North Carolina laws relative to cooperative organizations.

The active projects are as follows:

1. Farm Reorganization and Management.
2. A study of Methods and Practices Employed in the Production of Cotton and Tobacco.
3. A study of Factors Influencing the Production Costs on Dairy Farms in Piedmont North Carolina.
4. A study of Peach Orchard Management.
5. A study of Dairy Cattle as a Supplementary Enterprise to Cotton Farming in the Piedmont Section of North Carolina.
6. A study of Organization and Management of Farms Operated by Cropper Labor.
7. Factors which Influence the Cost of Producing Farm Crops.
8. Cotton Marketing.
9. Methods and Practices of Cooperative Associations.

## FARM ORGANIZATION AND MANAGEMENT

R. H. ROGERS, *Associate Agricultural Economist*.

**Farm Management in the Piedmont Area.** The work in farm organization and management has been continued in the Piedmont area of North Carolina. During 1929 sixteen farmers cooperated in keeping detailed records of their farm business. Several of these farms were selected for more detailed study in 1930-31. The general objective of work in this field is to determine for each area of the State the combination of crop and livestock which will probably give the maximum long-time net returns. In the case of the Piedmont study the work has been expanded so as to include the reorganization of some of these farms and to observe results of the changes made.



The results of the first two years have been tabulated and partially analyzed. To make the study more inclusive, a supplementary investigation will be made of dairy farms in 1931.

**Farm Reorganization Study.** This project is being conducted in co-operation with the Bureau of Public Roads, U. S. Department of Agriculture. The purpose of the study is to determine the economic benefits to be secured on typical farms in the eastern Piedmont and western Coastal Plain areas of North Carolina by means of a better physical development of farms, a better planned farming system, and the use of modern equipment. This work is being conducted on thirteen farms—six in Wake County, and seven in Johnston and Wayne Counties. The Bureau of Public Roads has assisted in making a detailed map of each farm. These maps show the field divisions, crop areas, waste land, wood land, ditches, fences, location of the buildings, etc. With these maps and personal knowledge of the farms and farmers, together with a farm business record for 1930, a reorganized plan has been prepared for each farm.

Each cooperator has been given a summary of his 1930 financial statement, a map of his farm as operated in 1930, a detailed plan of reorganization, including a proposed farm layout shown by a map, a systematic cropping plan, and a budget based upon the proposed changes. These plans have been approved by the cooperators as being workable and sound, but lack of finances and prospective low prices have retarded adoption of the suggestions in full. Some of the farmers are planning to start a cropping system in 1932 that is in line with the recommendations, and over 31,600 feet of terraces and 700 feet of shallow, open ditches have been constructed preparatory to changes in field layout.

**Methods and Practices Employed in the Production of Cotton and Tobacco.** This project was started February, 1930. The fundamental object of this project is to obtain data relative to the economical production of these two important cash crops in order that the net income on these and similar farms may be increased.

To obtain the basic information, 36 farmers in Wayne and Johnston counties cooperated in keeping production records on a total of about 470 acres. The records obtained on the 1930 crop are in detail including size and shape of fields, size and make of the various equipment used, time spent in performing the different field operations, kind and quantity of fertilizer used, variety of seed, rate and time of seeding, etc. In Table VIII is presented a summary of the results of this study. The work is being continued with only a slight change in the cooperators and includes a study of tobacco production on about ten farms in 1931 in addition to the cotton production study.

**Organization and Management of Cropper Farms.** This project was started in 1928. From the results obtained, one bulletin has been published entitled "Credit Problems of North Carolina Cropper Farmers." During 1931 sixty-two of the same farms surveyed in 1928 were re-surveyed. At the present time, the data are being subjected to further analysis with the idea of preparing a manuscript showing just how these farms are organized and operated and to point out the factors influencing the income obtained.

In Table IX is presented a summary of the results which is of interest at this time. These data show that income between 1928 and 1930 has declined quite markedly. While the situation is not encouraging, it should be pointed out that it is not entirely hopeless. Not all farmers lost money in 1930. (Table IX.) There were 13 farms of the 62 that actually made a fair return on their investment. The success of these few farmers may be traced to better than average farm organization, better management and better farm practices.

TABLE VIII.—SUMMARY OF COTTON COST STUDY, 1930  
471 ACRES—36 FARMS—JOHNSTON AND WAYNE COUNTIES

Item	Average Cost per Acre	Percent of Total Average Cost	Acre-cost on Low-cost Farm	Acre-cost on High-cost Farm	Acre-cost on High-yield Farm
Man labor.....	\$13.07	31.0%	\$11.10	\$11.21	\$16.84
Power (horse, mule, tractor).....	7.33	17.4%	5.45	8.33	10.89
Seed.....	1.65	3.9%	1.62	.95	1.25
Fertilizer.....	9.44	22.4%	8.96	12.36	6.31
Poison material.....	.45	1.1%	.....	.29	.69
Ginning.....	2.15	5.1%	2.63	1.43	2.95
Equipment use and miscellaneous.....	1.25	2.9%	1.25	1.25	1.25
Land charge.....	6.85	16.2%	7.00	6.60	7.00
Total Charges.....	\$42.19	100.0%	\$38.01	\$42.42	\$47.18
Seed Credit.....	7.08	.....	10.74	3.70	10.04
Net Cost per Acre.....	\$35.11	.....	\$27.27	\$38.72	\$37.14
Yield per Acre (lbs. lint).....	370.3	.....	472.6	205.3	516.9
Cost per lb. (cents).....	9.5	.....	5.8	18.9	7.2

**Cost of Producing Strawberries.** The cost of producing strawberries is a joint project between the North Carolina Experiment Station and the United States Department of Agriculture. The field work was done in 1928. Since then the data have been tabulated, analyzed and a manuscript prepared. A bulletin will be published shortly by the U. S. Department of Agriculture, which will include not only the cost of producing strawberries in North Carolina, but also in the other important areas of the United States. To those who may be interested in this subject reference is made to the data published in the Fifty-Second Annual Report.

**Cost of Producing Farm Products in North Carolina.** As pointed out in our annual report of last year, the Department of Agricultural Economics has been collecting data on farm organization and management for a period of years. These data are useful not only for the purpose of setting up systems of farming, but also in determining the cost of producing farm products. During the past two years considerable work has been done in assembling this material with the object of preparing a bulletin on the cost of producing farm products in North Carolina. This work has been advanced to the point where a manuscript is now being prepared and which will be submitted for publication during 1932. This bulletin should be useful in assisting farmers to economize their resources, as well as giving a better understanding of the use and nature of cost material.



TABLE IX.—AVERAGE INCOMES ON 62 COASTAL PLAIN FARMS, 1928 AND 1930

Item	Edgecombe County		Wayne County		Lenoir County		Pitt County		Total	
	1928	1930	1928	1930	1928	1930	1928	1930	1928	1930
No. of farms.....	15	15	18	18	15	15	14	14	62	62
Size of farm (Crop acres).....	248	239	126	130	102	97	92	95	142	140
<b>Investments:</b>										
Real Estate.....	33,080	27,378	17,064	15,541	14,230	11,954	17,594	14,491	20,373	17,300
Livestock.....	1,945	1,894	886	973	781	633	778	713	1,092	1,055
Machinery and Equipment.....	1,570	1,250	554	506	558	313	532	564	796	652
Feed and Supplies on hand.....	1,477	1,414	611	430	538	411	329	422	739	662
Cash to run farm.....	4,567	2,787	1,378	758	633	700	1,643	1,129	2,029	1,318
Total (Dollars).....	42,639	34,723	20,493	18,208	16,740	14,011	20,876	17,319	25,029	20,987
<b>Receipts:</b>										
Crops.....	15,272	7,567	5,157	3,761	6,775	3,179	7,198	4,111	8,457	4,620
Livestock (Increase) *.....	494	870	190	221	98	201	347	426	277	420
Feed and Supplies (Increase) *.....	.....	.....	.....	.....	15	2	36	.....	.....	.....
Other sources.....	103	140	118	16	120	75	79	13	106	36
Total (Dollars).....	15,860	8,477	5,465	3,998	7,008	3,457	7,660	4,550	8,840	5,076
<b>Expenses:</b>										
Current.....	11,204	7,326	3,933	2,988	4,253	2,482	5,013	3,598	6,013	4,052
Unpaid family labor.....	75	192	200	472	269	160	62	89	155	242
Feed and Supplies (Decrease) **.....	103	61	43	55	.....	.....	.....	14	26	34
Depreciation.....	628	526	311	317	331	248	253	292	379	345
Total (Dollars).....	12,010	8,105	4,487	3,832	4,853	2,890	5,238	3,993	6,573	4,673
Farm Income (Dollars).....	3,850	372	978	106	2,155	567	2,332	557	2,267	403
Interest (5% on investment).....	2,113	1,736	1,025	910	837	701	1,044	866	1,251	1,049
Labor Income.....	1,718	—1,364	—47	—744	1,318	—134	1,288	—309	1,016	—646
Interest earned (Percent).....	5.92	—43	.83	—1.3	6.73	1.81	9.01	.57	5.26	—1.13
Value of items for family use.....	492	480	425	502	457	436	357	333	434	442
Value of operator's labor.....	1,327	520	807	403	1,028	313	651	459	951	430

\*Increase in inventory.

\*\*Decrease in inventory.

## INVESTIGATIONS IN THE MARKETING OF FARM PRODUCTS

JOSEPH G. KNAPP, *Associate Agricultural Economist.*

**Grade and Staple of North Carolina Cotton.** This study, started in 1928, is carried on annually in cooperation with the Division of Cotton Marketing, Bureau of Agricultural Economics, United States Department of Agriculture. It is designed to furnish data on the quality of cotton produced in North Carolina. The grade and staple reports for the 53 gins which cooperated in the work for the 1930-31 cotton crop are grouped (Table X) into the three distinctive cotton producing regions. (1) Tidewater, (2) Upper Coastal Plain, and (3) Piedmont. (A map showing these areas was published in the Fifty-third Annual Report, p. 36.)

TABLE X.—AVERAGE PERCENTAGES OF GRADES AND STAPLE LENGTHS GINNED IN NORTH CAROLINA BY REGIONS OF THE STATE, 1930-31.

Region	Grade			Staple Length		
	White Middling and Better	White S. L. and Low Middling	Other Grades	15/16" and Over	7/8" and 29/32"	Under 7/8"
I.....	67.9	28.8	3.3	39.1	55.5	5.4
II.....	75.9	16.4	7.7	44.5	49.9	5.6
III.....	63.3	11.9	24.8	43.8	54.5	1.7
State Average.....	69.0	19.0	12.0	42.5	53.3	4.2

In comparison with the data for 1929-30, both grade and staple averaged higher in 1930-31. There was also smaller differences in quality of cotton grown in the three producing sections of the State.

**Consumption and Production of North Carolina Cotton.** This project is continued from past years. Information on mill consumption was obtained directly from North Carolina mill operators through questionnaires. The preliminary data from 72 mills consuming 310,720 bales of cotton in the year ending July 1, 1931, indicate that over 57 percent of their consumption of cotton for that period was obtained from outside of North Carolina. Over 20 percent of this imported cotton came from Mississippi. A large amount of cotton was also imported from South Carolina, Georgia and Oklahoma. A comparison of production of cotton by staple length with consumption of cotton by staple lengths explains to a large extent why North Carolina mills imported so much cotton to fill their requirements. North Carolina does not produce enough cotton of medium to long staple length to meet the requirements of North Carolina mills, but does produce more cotton of short staple length than is required.

The home market for cotton should be emphasized. There was an out-of-state movement of 214,579 bales of North Carolina cotton, in spite of the fact that the consumption of cotton by North Carolina mills for the year ending July 1, 1931, was 1,252,144 bales, while the production for 1930 was only 800,582 bales. A considerable part of this cotton which was shipped out of the State was of short staple lengths which were not in demand by North Carolina mills.

**Cotton Marketing and Price Study.** This study was reported in considerable detail in the Fifty-third Annual Report. The data collected from local markets for three years are now being analyzed to determine to what extent local prices reflect differences in prices paid for different qualities of cotton on the terminal markets. This project will be completed by July, 1932.

The data discloses the interesting fact that different local markets show considerable variation in prices paid for cotton of same grade and staple. The average prices of  $\frac{7}{8}$ -inch middling white cotton for eight local North Carolina markets in the month of October, 1930, were: 9.61; 9.66; 9.77; 9.99; 10.01; 10.02; 10.18; 10.36.

This study indicates that the premiums which are paid for longer staple in the terminal markets are not reflected back to the growers. Likewise, premiums paid for higher grades at the terminal markets are not reflected to the growers in the local markets. For illustration, in the period from October 1, to December 20, 1930, there was an average premium of 39.75 points, or \$1.99 per bale being paid in the central markets for 15/16-inch middling white cotton over  $\frac{7}{8}$ -inch middling white cotton, while the average premium in five local markets for 15/16-inch middling white cotton over  $\frac{7}{8}$ -inch middling white cotton was 7.8 points, or 39 cents per bale. For the same period an average premium of 30 points, or \$1.50 per bale, was being paid in the central markets for strict middling  $\frac{7}{8}$ -inch white cotton over middling  $\frac{7}{8}$ -inch white cotton, whereas in five typical local markets the average premium for strict middling  $\frac{7}{8}$ -inch white cotton was 4.02 points, or 20 cents per bale. The price study shows clearly that in general cotton farmers of North Carolina do not sell their cotton in accordance with its quality value. Under present marketing methods, excepting the cooperative method, insufficient premium is paid to farmers producing high quality cotton.

**Buying and Selling Practices of Ginners of Piedmont North Carolina, 1930-31.** This study was conducted by G. R. Smith, joint field representative of the Experiment Station and the United States Department of Agriculture. The project endeavored to evaluate general buying and selling practices of 145 ginners in nine Piedmont counties of North Carolina. The information was gathered through direct interviews with ginners. It was found that the size of the territory of the ginner was small. At least 60 percent of the cotton was grown within three miles of the gin and 87 percent within six miles of the gin. The size of the ginning community varied directly with the intensity of the cotton production in the county.

The study indicated that approximately 52.8 percent of the cotton grown in Piedmont North Carolina for the 1930-31 season was bought by the ginner who ginned the cotton. A small percentage of the ginners operated supply stores. Very little cotton was bought in the seed. Over seventy-four percent of the cotton bought by ginners was purchased on an independent basis. In other words, the ginner did not buy on commission or salary, but purchased on his own account.

Approximately two-thirds of the cotton bought by ginners in this territory was sold direct to mills. Most of the balance was sold to merchants that sold direct to mills. It should be remembered that textile manufacturing is the major industry of this area. The bulk of the cotton was not

bought in accordance with the value of each individual bale, but in accordance with the average quality of the cotton in the community. Practically all of the cotton purchased by ginnermen was shipped to its destination by truck.

**Methods and Practices of Cooperative Associations.** This project is designed to secure detailed information on the methods and practices used by cooperative organizations in North Carolina. In this study a distinction is made between formal, or "organized" cooperative associations and informal, or "unorganized" associations. Information on such topics as, number of members, type and nature of marketing services, use of contracts, methods of operating, system of financing, and affiliations with other organizations has been secured from about 30 of the formal associations and 40 of the informal associations either through personal interviews or questionnaires.

This study which will be completed during the current year, will suggest means for strengthening the cooperative movement in North Carolina.

## RURAL SOCIOLOGY

C. HORACE HAMILTON, *Associate Rural Sociologist.*

During the past year the Department of Rural Sociology completed two projects which has been carried over from the previous year; namely, (a) "A study of one hundred and fifty-four rural communities in seven typical North Carolina counties," and (b) "A study of the influence of community factors upon family living among white farm owner and tenant operators in Wake County, North Carolina." Six manuscripts on the above projects have been submitted for publication by Professors Carl C. Taylor and C. P. Loomis.

On January 1, 1932, C. Horace Hamilton will have charge of research work in Rural Sociology within the Department of Agricultural Economics to which the division of Rural Sociology has been transferred. While no specific projects have been outlined, plans are being made to develop a sound practical and scientific program of research in the field of rural sociology. During the next five years it is planned to develop and carry out research along the following lines: (1) Studies of rural organization and rural community life; (2) Studies of farm family relationships and functions in relation to improvement of farm life; (3) Studies of the social attitudes of farm people in relation to the development of co-operation and organization; and (4) Studies relating to the human and social factors in the economic life of the farmer. It is the plan to carry out projects which are closely related to the practical social problems of farm people. Problems will be studied for the purpose of furnishing principles and policies which can be utilized immediately and directly by farm people in their organizations and institutions. It is believed that this type of research will at the same time yield valuable results from the scientific viewpoint.

G. W. FORSTER,

*Head, Department of Agricultural Economics.*



## RESEARCH IN AGRONOMY

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The workers of the Department have devoted themselves actively to a solution of the vital problems which have confronted farmers of the State in the fields of soil chemistry, soil fertility, crop rotation, and plant breeding.

The work in soil chemistry has centered mainly on further studies of the magnesium deficiencies of Durham and Norfolk sandy loams and of factors influencing the productiveness of peat and muck soils.

Soil fertility field investigations, located on the Central Station farm and at the six branch stations, have been continued. Supplementing the work at these farms, fertility experiments have been conducted on 41 private farms in 19 counties. These experiments are designed to learn the fertilizer requirements of cotton, corn, peanuts, Irish potatoes, sweet potatoes, soybeans, and strawberries when grown on important soil types of the Coastal Plain, Piedmont and Mountain sections of the State. Sixteen of these experiments are being supported by the N. V. Potash Export My. and by the American Superphosphate Institute.

Systematic crops rotation experiments are being conducted at the Upper Coastal Plain, Piedmont and Mountain Branch Station farms. These studies are supplying valuable information regarding the influence of crops upon succeeding crops in the rotation and the fertilizer requirements of crops grown in a definite rotation.

The plant breeding and crop improvement investigations have secured splendid results with cotton, soybeans, peanuts, alfalfa, corn, red clover, lespedeza, wheat and rye. Farmers of the State are quite generally using strains and varieties of these crops which have been originated by or found to be of superior value in comparative field experiments by workers of the Station. Results from the depth of planting, and spacing experiments with different crops have been adapted quite generally by farmers of the State.

### SOIL EXAMINATIONS FOR FARMERS

During the year approximately two thousand samples of soil have been received from farmers of the State with requests for examination and information regarding fertilizer and lime requirements for crops they are growing.

The results of soil surveys and field tests of fertilizer and lime requirements of the various soil types of the State have made possible the supplying of definite and helpful information to such inquiries.

### SURVEY OF SOILS OF THE STATE

This work which is conducted in cooperation with the Soil Survey section of the Federal Bureau of Chemistry and Soils, has progressed actively. Two Federal and two State men have been kept busy in the field in mapping and in classifying soils and in preparing reports and soil maps of the counties in which work is being conducted.

During the year Franklin County has been finished, and about one-third of Chatham and four-fifths of Brunswick counties have been completed, and work is well under way in Surry County.

## TOBACCO FERTILIZER AND LIME RECOMMENDATIONS FOR 1932

Workers of this Department and the Agronomy Departments of Virginia, South Carolina and Georgia, and the Office of Tobacco and Plant Nutrition of the U. S. Department of Agriculture have prepared and issued fertilizer and lime recommendations for the growth of flue-cured, sun-cured, and shipping tobacco. These recommendations are quite generally used by fertilizer manufacturers and growers for guidance in mixing fertilizers for producing tobacco of high quality and good yield.

### TECHNICAL SOIL PROBLEMS

**Magnesium Deficiencies of Some Representative Sandy Soil Types.** This investigation has been continued according to the original plan. The Norfolk and Dunbar sandy loam soils that received 1 and 5 tons of dolomitic and calcite four years ago are still productive, but the unlimed soils will not now support the growth of soybeans.

The dolomitic lime has been uniformly superior to the calcite, and symptoms of magnesium deficiency with the latter point to the conclusion that magnesium is a limiting factor. Analysis of leachings from the several treatments have shown for the first time a distinct depression in the solubility of the soil magnesium as a result of the calcite applications.

After four years, the five-ton rates of liming are showing a superiority in point of yield to the one-ton rates.

Sulphate of potash continues to show a greater efficiency than the muriate which is not reflected in the mineral analyses of the leachings. The differences in soybean growth are less than in previous years, probably because of the reduction in loss of sulphates by leaching during two dry seasons.

There have been no significant differences in the calcium and magnesium content of the leachings as influenced by the form of potash salt.

An interesting observation was made that in an early summer drouth the grasses wilted more on the limed than on the unlimed soils.

Magnesium deficiency symptoms have been observed on a wide variety of plants growing in the field and in several cases the diagnosis has been confirmed by pot tests. In some cases the pH values of the soils have indicated that lime has been applied to the limit of reaction considered advisable and fertilization with sulphate of potash-magnesia has been suggested as a corrective measure.

**Factors Influencing the Productivity of Peat and Muck Soils.** Several observations of a response to fertilization with copper sulphate on soils of this classification, together with the fact that heavy applications of lime on these soils has produced ill effects with evidence of increased assimilation of iron, suggested a study of the effect of liming on the oxidation-reduction potential of a soil. The results show that liming increases the reductiveness of the soil used in the experimental work with the shift in potential being approximately in a direct ratio with the increase in pH values. Copper sulphate increased the oxidativeness of both a limed and an unlimed soil. It is thought that these results may explain the apparent increase in solubility of the soil iron with liming on soils of

low oxidizing intensity by converting the slightly soluble ferric iron to the more soluble ferrous form.

### **EFFECT OF pH OF SOILS UPON THE PREVALENCE OF BLACK ROOT-ROT OF TOBACCO**

During the year this Department, in cooperation with the Department of Botany, has conducted careful field observations and experiments to determine the relationship of the pH reaction of soils to the black root-rot infection of tobacco. From a limited number of observations, linked with field results, it has been found that all occurrences of black root-rot of bright and burley tobacco have been on soils having a pH reading above 5.4. Where infection occurred on soils with a reaction between 5.4 and 6.0, the damage was much less severe than where it was present in fields having a pH reading above 7.0.

### **STUDY OF THE DEVELOPMENT AND CLASSIFICATION OF THE DURHAM SERIES OF SOIL**

Chemical analyses of Durham sandy loam, Durham fine sandy loam, and Durham coarse sandy loam soils made by the North Carolina Department of Agriculture show a variation in potash content from 0.1 percent to more than 3 percent. In order to find out if this variation in potash could be correlated with the physical characteristics of the soil, ten samples of soil were collected from different locations in the State for analysis. These soils were described in the field and brought to the laboratory for mechanical analyses and microscopic examination of sand grains to determine the amount of potash feldspars present.

It was found that the two samples of soil lowest in potash had the characteristics of Helena sandy loam which has been recently separated from the Durham series. This soil differs from the Durham sandy loam in that it is derived from a quartz diorite rather than from a granite or granitoid gneiss and in having a highly plastic clay B horizon. The amount of clay in the B horizons of the Helena averages higher than in the B horizons of the soils which would still be classed as Durham soils although certain of the Durham samples ran slightly higher in clay than the lowest Helena sample.

Although the soils lowest in potash proved to be Helena rather than Durham there is still a wide range in potash content in the fine sand separates. The high potash soils contained from 12 to 15 percent, while the low potash soils contained from 1 to 8 percent of these minerals.

The fine sands from the Helena soils contained over 50 percent plagioclase feldspars, mostly albite or soda feldspar.

### **RESULTS OF SOIL AND FERTILIZER EXPERIMENTS**

#### **COASTAL PLAIN BRANCH STATION**

**Fertilizer and Lime Requirements for Crops in Three-year Rotation on Norfolk Fine Sandy Loam.** In this experiment there are twenty fertilizer treatments made in duplicate. One series has been limed at the rate of 2,000 pounds per acre of ground dolomitic limestone every three years since 1917. A three-year rotation of corn, oats-and-vetch, and soybeans for seed with winter cover crop, is followed.



For the production of corn, nitrogen has been found the most deficient nutrient, although a complete fertilizer containing phosphoric acid and potash is essential for most economical production.

Oats-and-vetch and soybeans have responded best to an application of about 400 pounds per acre of an 8-2-4 (PNK) fertilizer. Increasing single nutrients in this mixture did not materially increase the yield of either crop.

The yields of corn and soybeans have been materially increased by the use of lime. The lime, however, has not increased the production of oats-and-vetch hay but has materially affected the percentage of these two crops in the hay, increasing the legume and decreasing the oats. The amount of root-rot in corn was materially increased by liming and was greatly reduced by increasing applications of potash.

A manganese deficiency chlorosis appeared on all legumes grown on the limed series except in the case of those receiving large applications of potash in the form of manure salt. This chlorosis, however, has not appeared on any of the plats of the unlimed series.

**Fertilizer and Lime Requirements for Crops Grown on Dunbar Fine Sandy Loam in a Three-year Rotation of Corn, Oats-and-Vetch and Soybeans.** In this experiment the same amount of nitrogen, phosphoric acid and potash is applied to each crop harvested as is normally removed by each crop from the soil. These amounts are very much in excess of those commonly applied to the crops in the three-year rotation of corn, oats-and-vetch and soybeans. Fifteen years' results clearly show that the most economical amount of fertilizer to use for these crops cannot be determined by the amount of the various nutrients removed from the soil and that this is not a satisfactory method of determining the best fertilizing practices. The use of one ton of ground dolomitic limestone every three years since 1917 has not proven profitable.

#### UPPER COASTAL PLAIN BRANCH STATION

**Comparison of Sulphate of Ammonia and Nitrate of Soda when Used Separately and when Used Together to Supply Equal Quantities of Ammonia in an 8-6-4 (PNK) Fertilizer for Cotton.** Three years' results indicate that there is very little difference in the efficiency of these two sources of nitrogen for cotton grown on this type of soil. When either was used as the sole source of nitrogen in an 8-6-4 (PNK) mixture the yields were not as large as when the nitrogen was derived from both sources. Stand counts show very little difference in the effect of nitrate of soda and sulphate of ammonia on the germination of cotton.

**Efficiency of Different Sources of Nitrogen when Compared in a Complete Fertilizer and Measured by the Yield and Quality of Cotton Produced on Norfolk Sandy Loam.** Inorganic nitrogenous materials such as leunaspeter, urea, calurea, calcium nitrate and nitrapo, like nitrate of soda and sulphate of ammonia, have given slightly better yields than has cotton-seed meal used as the sole source of nitrogen in a 10-4-4 (PNK) mixture.

**Comparison of Complete Fertilizer Differing in Concentration when Measured by Stand and Yield of Cotton on Norfolk Sandy Loam.** On this soil, which is a rather heavy type Norfolk sandy loam, concentrated fertilizers, such as 15-5-5 (PNK) and 30-15-15 have been as efficient as less

concentrated mixtures. Contrary to results obtained on some lighter soils, the stand of cotton was no more severely injured from the concentrated fertilizers than from the ordinary commercial mixtures made from nitrate of soda, sulphate of ammonia, superphosphate and manure salt.

A study of the yields and quality of succeeding crops when corn and cotton are grown continuously and when grown in combinations with each other and with legumes in two- and three-year rotations on Norfolk sandy loam.

A study of yields and quality of succeeding crops when cotton, corn, small grain and peanuts are grown continuously and when they are combined in 2-, 3- and 4-year rotations on Norfolk sandy loam.

Results from these two crop rotation experiments started in 1910 and 1924 respectively, have shown that corn and peanuts respond more favorably to rotations with legumes than does cotton. The yields of corn and peanuts increased at the length of the rotation increased up to four years, or as the amount of cover crops grown and turned in for soil improvement was increased. Cotton yields are increased by three- and four-year rotations, but cotton grown continuously yielded better than when in a two-year rotation with corn. The following table gives the yields for 1930 of corn and cotton following five different rotations started in 1924:

INFLUENCE OF ROTATIONS UPON THE YIELD OF CORN AND COTTON

Rotation	Number Years of Rotation	Crops in Rotations	Yield per Acre	
			Corn Bus.	Seed Cotton Lbs.
1.....	Continuous.....	Corn, with crimson clover and rye.....	18.9	
2.....	Continuous.....	Cotton, with crimson clover and rye.....		650
3.....	2-year.....	Corn, with crimson clover and rye.....	26.7	
		Cotton with crimson clover and rye.....		590
4.....	3-year.....	Peanuts, with crimson clover and rye		
		Corn, with cowpeas.....	32.8	
		Cotton, with crimson clover and rye.....		890
5.....	4-year.....	Corn, with cowpeas; rye (for seed).....	47.2	
		Soybeans (for seed); cotton, oats-and-vetch		
		soybeans (soil improvement).....		860

The vegetative growth of cotton has been much more vigorous in the 4-year rotation than in the 3-year rotation, but the yield of cotton was not so large.

**Fertilizer and Lime Requirements for Corn and Soybeans Grown in Rotation, the Soybeans Being Utilized for Seed Production in One Series and for Hay Production in Another on Okenee Fine Sandy Loam.** The object of this experiment, started in 1926 is to determine the best fertilizer for corn, soybeans (for seed) and soybeans (for hay) and to show the effect upon the succeeding crop of corn of picking soybeans for seed (the stems and leaves turned under for soil improvement) versus cutting them for hay. The results thus far obtained with corn were reported in the N. C.

Station Report for 1929-30. From the results it was evident that the difference in the fertility of the series on which the soybeans were picked for seed and the one one which they were cut for hay is becoming greater each year. The increase in yield of corn in favor of picking soybeans for seed was 25 percent in 1927 and 61 percent in 1929.

The following table gives a five-year average of the effects of different fertilizer mixtures upon the yield of soybeans for seed and hay:

RESPONSE OF SOYBEANS TO FERTILIZER AND LIME

Fertilizer		Average Yield Soybean Seed— Bus. per Acre	Average Yield of Soybean Hay— Pounds per Acre
Pounds per Acre	Formula		
400.....	8-2-0	10.2	2200
400.....	0-2-4	14.2	3120
400.....	8-0-4	14.5	3520
400.....	8-2-4	13.9	3520
400.....	8-2-4-L	15.5	4040
No fertilizer.....	0-0-0	10.5	2120

From these results it is evident that for this type of soil the use of fertilizers is much more effective in increasing the yield of hay than the yield of seed. The use of lime in addition to complete fertilizer has given the largest yield of both hay and seed. For the production of corn, however, lime has been ineffective.

#### BLACKLAND BRANCH STATION

**Rock Phosphate, Superphosphate and Duplex Basic Slag Compared as Sources of Phosphoric Acid for Corn, Oats, Soybeans, Irish Potatoes and Soybeans Grown in a 3-Year Rotation on Muck.** This experiment is run in a three-year rotation of corn; oats, soybeans (for soil improvement); and Irish potatoes, soybeans (for soil improvement). It is designed to determine the efficiency of various phosphate carriers and varying amounts and proportions of commercial fertilizers. There are three series of eight plats each so that each crop is grown every year.

Ten years' results from this experiment show that potash is the most essential plant nutrient for the production of corn, oats, Irish potatoes and soybeans grown on this type of soil. Phosphoric acid applied either in the form of rock phosphate, basic slag or superphosphate was not effective in increasing the yield of any crop. The use of nitrogen and phosphate rarely produced yields greater than the unfertilized plats, while when potash was added to this mixture the yields were usually about doubled. Root-rot of corn occurs very severely on all plats which do not receive potash and is largely controlled by the use of potash on other plats.

**A Study of Sources and Rate of Application of Different Forms of Lime for Corn on Peat Soil when Used With and Without a Complete Fertilizer.** This experiment, run continuously in corn since 1917, was designed to compare the efficiency of hydrated lime, marl, and ground limestone when applied at the calcium carbonate equivalent of one, two, three and four tons per acre every three years.

As reported in the N. C. Station Report for 1929, using the average yield of corn as a measure, ground limestone would rate 100, hydrated lime 95, and marl about 90. During this year duplicate soil samples were taken from each plat and the hydrogen-ion concentrations determined by the quin-hydrone method. The results of the determinations are as follows:

RATE OF APPLICATION AND SOURCE OF LIME IN RELATION TO pH VALUE OF  
PEAT SOIL

Lime Application— Equivalent Rate CaCO per Acre	pH Reading			
	Ground Limestone	Hydrated Lime	Marl	No Lime
No lime.....	.....	.....	.....	4.1
One ton.....	4.6	4.6	4.7	.....
Two tons.....	5.4	5.5	5.2	.....
Three tons.....	5.7	5.7	5.9	.....
Four tons.....	6.8	6.8	6.8	.....

From the above data it is evident that any difference in yield of corn now on plats receiving the same rate of lime application is not due to differences in soil acidity. The results, however, show that the greatest differences in corn yields were obtained during the first few years of the experiment. The yields for 1930 were practically the same for all three sources of lime.

#### MOUNTAIN BRANCH STATION

**Fertilizer Requirement of Wheat Grown in a 3-Year Rotation on Toxaway Loam.** With wheat in a 3-year rotation of wheat, soybeans and corn on Field A, the highest yield was secured this year from the use of 800 pounds per acre of a complete fertilizer; however, the difference in yield between this application and that produced by 400 pounds of the fertilizer plus one ton of ground limestone per acre applied every three years was not sufficient to pay the cost of the additional fertilizer above 400 pounds. There was an increase of 7 bushels per acre from the use of 1 ton of ground limestone when added to a complete fertilizer. Omitting phosphoric acid from the fertilizer mixture reduced the yield more than did either nitrogen or potash.

The results obtained this year are very similar to those obtained for the average of six years.

**Fertilizer and Lime Requirements of Wheat when Grown in a 3-Year Rotation with Irish Potatoes and Soybeans on Toxaway Loam.** In this experiment with wheat, soybeans for hay, and Irish potatoes being grown in rotation on Field B, the results given below have been secured with wheat during the year.

In comparing sulphate of potash, muriate of potash and kainit, each as sources of potash in a complete fertilizer, the resulting yields show very little differences when 400 pounds of fertilizer are used per acre for a period of five years.



## SOURCE OF POTASH FOR WHEAT

400 lbs. fertilizer with potash from sulphate of potash	14.0 bu.
400 " " " " " muriate of potash	14.9 bu.
400 " " " " " kainit	14.5 bu.

When comparing 200, 400 and 800 pounds per acre of a complete fertilizer, results indicate that the use of 400 pounds gives best returns and that a complete fertilizer is more profitable than the use of nitrogen, phosphoric acid, or potash, or a combination of two.

**Rock Phosphate, Superphosphate and Duplex Basic Slag Compared as Sources of Phosphoric Acid for Corn Grown in a Corn, Wheat and Red Clover Rotation on Toxaway Loam.** Field G-2 is devoted to a study of the relative efficiency of four sources of phosphoric acid (superphosphate, rock phosphate, soft phosphate and duplex basic slag) when applied in a rotation of corn, wheat and red clover. The corn yields for five years indicate that superphosphate is the most efficient source of phosphoric acid with rock phosphate, basic slag and soft phosphate ranking in the order named. The results have been as follows for the different phosphate carriers when used to supply the phosphoric acid in 500 pounds per acre of a mixture analyzing 10-4-1½.

SOURCE OF PHOSPHORIC ACID FOR CORN GROWN IN ROTATION WITH  
WHEAT AND RED CLOVER

<i>Source of Phosphoric Acid</i>	<i>Corn—Bus. per Acre</i>
Superphosphate	54.7
Rock phosphate	50.6
Soft phosphate	45.5
Duplex basic slag	48.4

The yields of corn produced on the limed and unlimed series of this experiment show 3.2 bushels per acre increase in favor of the limed series. The yield on the series in which the nitrogen was derived from stable manure as compared with the yields on the series in which the nitrogen was derived from nitrate of soda show a slight difference in favor of the manure for corn on this type of soil.

**Rock Phosphate vs. Superphosphate as Sources of Phosphoric Acid for Corn Grown in Rotation on Toxaway Loam.****Comparison of Rock Phosphate and Superphosphate for Corn and Crimson Clover (turned under) in a 1-Year Rotation on Toxaway Loam.**

The studies being conducted on this field are with corn, oats, wheat and soybeans grown in rotation and with fertilizers applied in quantities equal to the amounts removed by maximum crops.

On a certain portion of the plats, the nitrogen is supplied by growing and turning under crimson clover as a winter cover crop. The phosphoric acid is supplied from two sources for a comparison—superphosphate and rock phosphate.

The results with corn this year are not in line with those of previous years, the highest yield being obtained on the plat which received double amount of phosphoric acid from rock phosphate with normal amounts of nitrogen and potash. The results secured on corn where crimson clover

was used as a winter cover crop for soil improving purposes before the corn show that a double application of phosphoric acid from rock phosphate increased the yield 47 percent, or 15 bushels per acre more than was produced by a single application from the same source, and 26 percent more than a single application from superphosphate. The average results for eighteen years, however, have shown that superphosphate has produced a larger yield of corn than has resulted from the use of the same amount of phosphoric acid from finely ground rock phosphate.

#### PIEDMONT BRANCH STATION (Cecil Clay Loam)

**Fertilizer and Lime Requirements of Corn and Cotton Grown in Rotation.** These experiments are being conducted on fields A, B and C to determine the plant food deficiencies of the Cecil soil of this farm, the proper proportions of nitrogen, phosphoric acid and potash for the leading field crops of the Piedmont region and to study symptoms of plant nutrient deficiencies and their effect on growth and yield of crops grown in rotation. On the three fields, used for this study, the following is used:

- 1st year—Cotton, rye (cover crop);
- 2nd year—Corn, wheat (in fall);
- 3rd year—Wheat, red clover;
- 4th year—Red clover.

One-half of all the plats in these fields is broadcast with one ton of ground limestone every fourth year. This year corn occupied Field A, cotton Field B, and Field C has been temporarily discontinued.

The yield of corn and cotton on their respective fields were closely in line with those of previous years. On plats where single nutrients were used, phosphoric acid gave the greatest increase in yield with nitrogen second in importance. Potash had very little effect in increasing yields, and its chief importance in the fertilizer seems to be in increasing the resistance of cotton to rust and corn to frenching.

Rust of cotton and frenching of corn were both very prevalent on plats which have received no potash or very small applications. This diseased condition of both crops has been found more pronounced on the limed than on the unlimed half of the plats. The yields have been higher on the limed than on the unlimed series, due apparently to the increased growth of the clover and added organic matter and nitrogen to the soil from the turning under of the second growth in the second year of the clover.

**A Comparison of the Efficiency of Ten Sources of Nitrogen in a Complete Fertilizer for Cotton.** This field is devoted to a study of the efficiency of the more common sources of nitrogen when used as single sources for the production of cotton and corn in a two-year rotation. The results secured with cotton this year when using 600 pounds per acre of a 10-4-2 (PNK) mixture and applying all the nitrogen in the mixture from the different sources as indicated, are as follows:

## INFLUENCE OF SOURCE OF NITROGEN UPON COTTON YIELDS

Plat No.	Nitrogen Carrier	Yield Seed Cotton per Acre—Lbs.
1.....	Nitrate of soda.....	845
2.....	Calcium cyanamid.....	775
3.....	Nitrate of ammonia.....	740
4.....	Sludge .....	690
5.....	Sulphate of ammonia.....	670
6.....	Cottonseed meal .....	650
7.....	Leunasalpeter .....	620
8.....	Urea .....	615
9.....	No nitrogen .....	585
10.....	No fertilizer.....	205

This experiment has not been in progress long enough, however, to draw definite conclusions as to the exact relative value of each of the sources for cotton when grown on this type of soil.

**Study of the Yields and Quality of Succeeding Crops when Wheat and Corn are Grown Continuously and when Grown in 2- and 3-Year Rotations With and Without Legumes.** This experiment on Field G consists of a study of one-, two- and three-year rotations, with and without legumes (cowpeas and red clover). The same quantity and analysis of fertilizer is used on each individual crop as it appears in the rotation. One-half of all plats are limed with one ton of ground limestone per acre broadcast every fourth year. Yields of corn for this year, though lower than the average, are very closely in line with the results of previous years.

## INFLUENCE OF LIME AND ROTATION UPON CORN YIELDS

	<i>Corn—Bushels per Acre</i>	
	<i>Unlimed</i>	<i>Limed</i>
Continuous corn.....	12.0	7.1
Two-year rotation, corn, wheat.....	18.9	14.6
Two-year rotation, corn, cowpeas, wheat, cowpeas .....	23.7	17.4

## CENTRAL STATION (Cecil Sandy Loam)

**A Study of the Effects of Varying the Ratio of Inorganic to Organic Sources of Nitrogen in a Complete Fertilizer Upon the Yield and Quality of Cotton.** Three series of plats are used in this experiment and in each a different source of inorganic nitrogen from nitrate of soda, sulphate of ammonia and leunasalpeter is used in varying proportions with organic nitrogen from cottonseed meal. In each of the three series, the proportion of 80 percent inorganic to 20 percent organic has given the largest yield, which results are in general accord with averages for the past four years.

**The Effect of Limestone, Burnt Lime and Hydrated Lime Upon the Yield of Corn Grown in a 4-Year Rotation.** This is a study of the comparative value of burnt lime, hydrated lime and ground limestone when applied every fourth year at rates equivalent to one, two and four tons of calcium carbonate per acre. On the field, soybeans for seed; rye, corn; oats-and-vetch for hay, soybeans for seed; cotton and crimson clover (for hay) are



grown in a four-year rotation. All plats have received phosphoric acid in equal amounts from superphosphate. No nitrogen or potash has been applied. The highest yield of corn for this year was obtained on the plat that received two ton of burnt lime per acre. The second highest was obtained from an unlimed check. The four-ton rate of application gave the lowest yields in all cases.

**Comparative Efficiency of Different Sources of Nitrogen Upon the Yield of Cotton.** This test is designed to study the effects of several carriers of nitrogen on the growth and yield of cotton when each is used as a single source. The nitrogenous materials used have been nitrate of soda, sulphate of ammonia, cottonseed meal, urea, leunasalt peter, nitrapo, sludge, fish scrap, cal-urea, hynite tankage, Swift's tankage, Kanona tankage, garbage tankage, Omega tankage, digester tankage, hoof and horn meal, Stellco tankage, cocoa shell meal, calcium cyanamid and calcium nitrate. This year the highest yield was obtained from calcium nitrate.

#### **RESULTS OF FERTILIZER EXPERIMENTS ON OUTLYING SOIL TYPE FIELDS WITH FARMERS OF THE STATE**

**Fertilizer Requirements for Corn Grown on Ashe Loam (Burke County).** The yields of corn in this experiment are in accord with the results of previous years. Phosphoric acid omitted from the fertilizer has reduced the yield more than has omitting either nitrogen or potash. Omitting the potash from the mixture resulted in practically no reduction in yield. Increasing the rate of application of fertilizer above normal of 400 pounds per acre has given good increases in yield. The use of lime has proven beneficial to this soil for corn.

**Fertilizer Requirements for Corn Grown on Toxaway Loam (Transylvania County).** This experiment is being conducted to determine the proper proportions and amount of essential plant nutrients to use in the production of corn and wheat when limed and unlimed. On this field the use of lime has not proven profitable. Increasing the percentage of phosphoric acid in a complete fertilizer has had more effect in increasing the yield than has an increase of either nitrogen or potash. Potash does not appear to be especially important at the present time. Dividing the application of nitrogen has given a small increase in yield over putting it all on at planting time.

**Fertilizer Requirements for Cotton Grown on Appling Sandy Loam (Davie County).** The results with cotton in this experiment this year were very much in line with the results obtained in previous years. There was very little difference resulting from the use of different sources of potash. Of the sources of nitrogen being tested, calnitro and calurea proved to be leaders in producing yield. The use of superphosphate has given a larger yield than has any other phosphatic carrier being tested. Profitable increases in yield were obtained by increasing the application of complete fertilizer up to 900 pounds per acre.

#### **SOIL FERTILITY FIELD EXPERIMENTS IN COOPERATION WITH BUREAU OF CHEMISTRY AND SOILS**

**A Study of Soil Conditions in the Chadbourn Area that Have Been Unfavorable to Strawberry Production.** Experiments were started in 1929

and 1930 to study the effect of various nitrogen and potash sources, the effect of concentrated fertilizers and rare elements, and the effect of the ratio of inorganic to organic nitrogen on plant growth, yield and quality of berries. This investigation also includes general fertilizer ratio experiments on different soil types to determine the best ratio of nitrogen, phosphoric acid and potash for strawberries.

More recently experiments have been started to study the effect of fertilizers upon root growth of plants and the flavor and keeping quality of fruit. Rotations and time of applying fertilizers in relation to yield and quality of strawberries are also being studied.

A preliminary report of the two years' results is given in Agronomy Information Circular No. 64. These results may be briefly summarized as follows:

Approximately 1,500 pounds of fertilizer per acre are used annually by growers on strawberries in this section. In the experiments, mixtures containing more than 6 percent ammonia gave a comparatively large percent of faulty and soft berries. Potash did not materially increase yield, but in most of the experiments its use influenced the quality of the berries. The fertilizer mixture giving the best results, when yield and quality both are considered, contained 8 percent available phosphoric acid, 6 percent ammonia, and 6 percent potash.

Fertilizers having their nitrogen derived partly from sodium nitrate and partly from organic materials, such as cottonseed meal, gave best results when the nitrogen was 80 percent from sodium nitrate and 20 percent from cottonseed meal. In mixtures containing ammonium sulphate and cottonseed meal, the proportion of 50 percent ammonium sulphate and 50 percent cottonseed meal proved best. Synthetic nitrogen as a source of nitrogen in fertilizers for strawberries gave good results, but the data thus far secured indicate that the nitrogen in fertilizers for strawberries should be derived partly from inorganic or synthetic sources and partly from organic sources of vegetable or animal origin.

Potassium sulphate, potassium chloride and kainit as sources of potash did not vary widely in their relative effect on strawberry yield.

The time of applying fertilizers is apparently an important factor in Klondyke strawberry production on the soils of the Chadbourn section. The full amount of fertilizers (1,500 pounds per acre) applied in late summer or early fall gave larger yields and earlier berries than did the use of split applications of fertilizers; i.e., one-half of the fertilizer applied in summer and one-half in winter.

The influence of varying the rates and methods of applying concentrated complete fertilizers upon the stand, yield and quality of sweet potatoes grown on Norfolk loamy fine sand in Currituck County.

Comparative efficiency of the same nutritive ratio but differing in concentration and source of materials for cotton. (a) When applied as single and fractional applications, and (b) when supplemented by rarer elements, such as magnesia, sulphur, copper, etc., on Norfolk sandy loam in Wayne County.

As a whole, the use of concentrated fertilizers have not given as large returns as equivalent amounts of plant nutrients per acre from ordinary

commercial mixtures with either sweet potatoes on Norfolk loamy fine sand or cotton on Norfolk sandy loam.

Supplementing the concentrated mixtures with calcium, magnesium, nickel, copper, zinc and manganese has increased their efficiency on many soils, and indicates that if highly concentrated mixtures are to be used year after year on the light sandy soils they will have to be supplemented with other materials not generally considered in commercial mixtures.

**A Study of Methods of Applying Concentrated Fertilizers to Cotton on Cecil Sandy Loam at the Central Farm.** To determine the effect of applying complete fertilizer ten days ahead of planting and immediately before planting on the germination and yield of cotton, four different fertilizer mixtures were used—two concentrated and two with equivalent amounts of plant food from materials that are commonly used. The results for this show that better stands are secured if the fertilizer is applied ten days before planting. By securing a superior stand, the results also show that the yield is increased. Applying the fertilizer on one side of the seed row about 4 inches from the seed has given an increase in yield of 23 percent over applying the fertilizer in contact with the seed.

The mixtures of commonly used materials have given larger yields than has the concentrated fertilizer.

**A Study of the Effects of Varying the Ratio of Inorganic to Organic Sources of Nitrogen in a Complete Fertilizer upon the Yield and Quality of Cotton on Cecil Clay Loam (Franklin County).** This experiment was designed to study the effect upon growth and yield of cotton when the proportion of organic to inorganic nitrogen in the fertilizer is varied. Cottonseed meal was used as the standard organic nitrogen source. In this field there are three series of plats, in each of which the inorganic nitrogen is derived from nitrate of soda, from sulphate of ammonia and from leunasalt peter. As in previous years, the higher proportions of inorganic to organic nitrogen have produced the largest yields. Sixty-five percent inorganic, 35 percent organic; 80 percent inorganic, 20 percent organic; and 90 percent inorganic to 10 percent organic were the proportions which gave the largest yields.

**Comparative Efficiency of Fertilizer of the Same Nutritive Ratio but Differing in Concentration and Source of Materials for Cotton on Cecil Clay Loam (Catawba County).** In a study of several concentrated fertilizer mixtures on this soil, it has been found that all were more injurious to germination than commercial mixtures made up of superphosphate, sulphate of potash, nitrate of soda, sulphate of ammonia, cottonseed meal and tankage. The yields from concentrated mixtures were generally less than from the commercial mixtures. The use of manganese sulphate in commercial mixtures has given some favorable response.

## COOPERATIVE TOBACCO EXPERIMENTS

### TOBACCO BRANCH STATION (Durham Sandy Loam)

All the tobacco work noted below is conducted in cooperation with the Office of Tobacco and Plant Nutrition of the U. S. Department of Agriculture and the State Department of Agriculture.

**Effects of Crop Rotation Upon Yield and Quality of Tobacco (Block 1).** These experiments consist of 63 plats planted to tobacco, corn, and cotton



after vetch, crimson clover, cowpeas, soybeans, fallow, grass and a check. The object of the experiment is to study the yield and quality of tobacco and yield of corn after each of these crops.

Results thus far obtained show that too much nitrogen was obtained from vetch and crimson clover to produce tobacco of high quality. Tobacco after cowpeas and soybeans was better, but the best quality of tobacco was obtained following a fallow. The yield of corn was greater after vetch. There was not much difference in the yield of cotton following vetch or crimson clover, but these two plats were the best in the cotton section.

**Quantative Magnesium Tests (Block 2).** The object of this experiment is to determine the amount of magnesia per acre necessary to prevent sand drown.

Results show that the presence of 20 to 25 pounds of soluble magnesia per acre will correct this deficiency.

**Four-Year Rotation Experiments (Block 3).** This rotation consists of first year, tobacco with crimson clover sown in the fall; second year, corn; third year, winter oats followed by soybeans. The soybeans are plowed under and the plats are then seeded to orchard, tall meadow oat grass and red top.

Results have shown that the fertility of the soil is gradually improved which would permit of a reduction in nitrogen in the fertilizer mixture for tobacco. Under this system most of the root diseases are kept under control. The quality of tobacco produced has been fair and the yield has been considerably above the average.

**Effect of Soybeans Preceding Tobacco Crop (Block 4).** The object of this experiment is to see if by leaving out commercial nitrogen in the fertilizer mixture sufficient yield and quality of tobacco could be produced to justify its adoption as a general practice. This experiment, carried on since 1912, has had no commercial nitrogen added but literal applications of superphosphate and sulphate of potash have been supplied the tobacco crop.

Results show that where all the nitrogen is derived from legumes, the quality of the tobacco is not as good as that produced on less fertile soils by the use of commercial nitrogen. However, the total-acre value from these plats is not much below the value of tobacco produced where nitrogen is supplied from commercial sources.

**Test of Sources of Nitrogen (Block 5).** The object of this experiment is to obtain information with reference to the relative value of different nitrogen carriers for tobacco. This block consists of 45 plats in which the different carriers of nitrogen are used at the rate of 20 to 40 pounds per acre respectively, in a complete fertilizer.

Data thus far obtained show that nitrate of soda as a sole source of nitrogen has given the best results of the inorganic sources. Sulphate of ammonia, when used with small quantities of dolomitic limestone, has been almost as satisfactory as nitrate of soda. Urea so far has given the best results of the synthetic nitrogen carriers. Cottonseed meal, fish scrap and sterilized ground tobacco stems have each given satisfactory results, with cottonseed meal proving the best of the organic group.

**Regular Fertilizer Tests (Block 6).** These tests are conducted in a three-year rotation and were begun in 1911 with some modifications in 1919 as to the cropping system and the basal application was changed from 8-5-10 to 8-4-6 (PNK) in 1929. The object of these tests is to determine the value of different mixtures and different individual sources of nitrogen, phosphoric acid and potash when used with and without dolomitic limestone. There are 72 plats in this series, half of which have been limed every three years at the rate of one ton per acre of dolomitic limestone and the other half remaining unlimed.

On the unlimed end of the plats, cottonseed meal has given best results. Nitrate of soda was second, dried blood third, and sulphate of ammonia fourth. On the limed end, sulphate of ammonia almost equalled nitrate of soda with cottonseed meal still at first place. On plats receiving a mixture of these four different sources of nitrogen, the results were slightly better than were those obtained from the individual sources. Basic slag and bone meal did not give as good results as superphosphate as carriers of phosphoric acid. The yield was satisfactory but the quality was not satisfactory.

**Test of Varieties (Block 7).** A large number of varieties have been tested both with regard to yield and quality of tobacco. Results have shown that Cash, White Stem Oronoco, Bonanza and Jamaica are the four leading flue-cured varieties.

**Potash, Sulphur and Chlorine Test (Block 8).** The object of this test is to determine the effect upon yield and quality of tobacco of sulphur and chlorine derived from the different potash salts. It has been found that where the chlorine and sulphur are kept constant in each of the plats practically no difference in the yield and quality of tobacco is obtained, provided the other essential plant nutrients are the same.

**Special Potash Experiments (Block 9).** The object of this experiment is to determine the comparative values of sulphate and muriate of potash. The experiment was started in 1915 and has been carried on continuously. Thus far, muriate of potash has given slightly better yields and values than has sulphate of potash in a complete fertilizer. On supplementary plats, where muriate and sulphate of potash both were used in the same plat and the chlorine kept low enough to cause no chlorine injury, slightly better results were obtained from the mixture than from the individual sources.

**Split Applications of Nitrogen Derived from Nitrate of Soda and Cottonseed Meal (Block 10).** This experiment is designed to determine the effect of these two sources of nitrogen when applied at different dates, also to determine the rate of absorption of ammonia by the tobacco plants during various stages of growth. As this experiment was only begun in 1930, no conclusions are available as yet.

**Fractional Applications of Fertilizer (Block 11).** This experiment is an extension of the test on Block 10 with the object of determining the value of fractional applications of a complete fertilizer mixture as compared to two or three applications of nitrogen alone and of nitrogen and potash. The experiment consists of 30 plats. As it was begun in 1931 no dependable data of value has yet been secured, although split applica-

tion of the basal fertilizer mixture gave better results under the 1931 seasonal conditions than where the nitrogen alone or nitrogen and potash were applied in two or three applications.

**Studies of Disease Resistance of Varieties and Strains.** Other tests have been made for the purpose of studying methods of control of black root-rot (*Thielavia*) and black shank. The tests consist of a comparison of a large number of varieties, both foreign and domestic on infected soils, to secure, if possible, a variety which is resistant to these diseases. Some progress has been made with the indication that a strain of tobacco which is resistant to black root-rot may soon be available to growers.

#### UPPER COASTAL PLAIN BRANCH STATION (Norfolk Sandy Loam)

**Fertilizer and Rotation Experiments.** In these rotations on Norfolk sandy loam of continuous tobacco; of cotton and tobacco; of corn, cotton and tobacco, the results thus far secured show that the three-year rotation is leading with the two-year next in total yield. The continuous tobacco plats have fallen down in yield badly this year.

In the lime experiment with calcic and magnesian lime, neither one has thus far given any beneficial returns. In the study of various proportions of plant nutrients, mixtures containing 6 to 8 percent phosphoric acid, 3 to 4 percent nitrogen and 8 percent potash have given best results.

**Sources of Potash.** In the sources of potash test, a mixture of muriate and sulphate of potash-magnesia has given most satisfactory results. The use of muriate of potash and manure salt gave a better color of the leaf than did the use of sulphate of potash.

**Top-dressing Experiment.** In this experiment, urea used as a top dresser, has given a better color of the leaf and less disease than did the use of nitrate of soda. Where heavy amounts of the nitrate were used, the tobacco had sand drown very severely.

The use of the heavier amounts of nitrogen seemed to affect the quality of the tobacco more than did the time of its application, provided the application was not delayed beyond three weeks after transplanting of the plants to the field.

The use of 100 pounds of potash in two applications did not seem to give results any different than when used under tobacco at planting time.

**Tobacco Stems.** The use of ground tobacco stems as the carrier of potash and nitrogen in the fertilizer has given good results when used at the rate of 500 pounds of stems per ton of the mixed fertilizer.

### INVESTIGATIONS WITH FIELD CROPS

#### COTTON EXPERIMENTS

**Inheritance Studies.** Results of investigations to determine the way in which the smooth, fuzzy-tip and fuzzy seed coat characters are inherited were given in the Fifty-third Annual Report of this Station. A technical paper giving these results has also been prepared for publication. Further study of the material from these crosses has yielded some interesting data on the inheritance of lint percentage, and linkage relations of lint percentage with certain seed coat characters. In a cross between a smooth

seeded low lint parent and a fuzzy seeded high lint parent, high lint percentage and smooth seed were dominant in the first generation, but in the second generation the 9:3:3:1 ratio expected from a cross involving two factors was not secured. The ratios secured were approximately 1 smooth-low lint: 2 smooth-high lint: 1 fuzzy-high lint. The smooth-low lint (5 to 22 percent lint) individuals all bred true for smooth seed and low lint percentage in the  $F_3$ . The smooth seed-high lint (23 to 32 percent lint)  $F_2$  plants all segregated for seed coat characters in the  $F_3$ , and the fuzzy seed-high lint individuals all bred true for these characters. Linkage of smooth seed with relatively low lint and fuzzy seed with high lint is shown. The wide range in lint percentage of the homozygous smooth seeded segregates (5 to 22 percent), and the fact that strains homozygous for the smooth seeded character have been isolated which have lint percentages ranging from 4 to 8 percent and 15 to 20 percent respectively, indicate that there is more than one factor influencing lint percentage, and that one or more of these factors act independently of the factor for fuzzy seed. The logical conclusion would seem to be that lint percentage is determined by more than one factor, and that one or more, but not all, of these factors are completely linked with the factor for fuzzy seed.

**Cotton Improvement.** Breeding work for higher yields, length and uniformity of staple, higher spinning quality and adaptation to boll-weevil conditions is being carried on at the Central and at two branch station farms. The individual plant-to-row method is used with the most promising rows going into strain tests the following years.

At the Upper Coastal Plain Branch Station, Mexican strain No. 87 has proven superior to the parent variety and other selections. Comparative yields for three years (1928-1930) has been as follows:

STRAIN YIELDS OF MEXICAN BIG BOLL COTTON, 1928-1930

Strain No.	Yield of Lint Lbs. per Acre	Per Cent Lint	Three Years' Staple Range Inches
87.....	484	36.1	1-1/16
26.....	410	35.1	1 to 1-1/16
10.....	423	36.0	1 to 1-1/16
18-7*.....	444	35.9	1 to 1-1/16

\*Parent of other strains.

A number of other strains were discarded during the first and second years. Two one-variety communities and a number of individuals are growing this strain.

At the Central farm two promising strains of Mexican have recently been developed. These are Nos. 58 and 128. Strain No. 58 is being increased on the Central farm, and seed is being distributed. After several years comparison in the strain test, a few bushels of No. 128 were supplied to the Woodleaf Seed Association. This group of farmers are growing approximately 600 acres of this strain in 1931. A number of



other communities are growing Mexican seed which was bred by the station.

Strains which show promise on the Central farm are grown in trial tests on the Piedmont Branch Station farm. Strains Nos. 128, 58 and 58-14 have proven best. Strain No. 58-14 is being increased for distribution.

Crosses between different strains of the Mexican variety were made at the Central and Upper Coastal Plain Branch Station farms in 1929 with the object in view of increasing fruiting vigor. The parent strains had about the same staple length, and boll and seed type but differed slightly in other plant characters. The  $F_1$  plants of the different crosses showed some difference in fruiting qualities and growth, but due to the limited number of  $F_1$  plants no accurate comparisons of yield or vigor could be made. The second generation is being grown in 1931.

**Cotton Spacing.** Tests to determine the optimum distance between hills and the advisability of planting with a hill-dropper and not thinning were made on the Upper Coastal Plain and Piedmont Branch Station farms. The very dry spring of 1930 caused such a poor stand on the Upper Coastal Plain Branch Station that results were of no value, but good stands were secured at the Piedmont Branch Station. The highest yield and also the earliest crop was secured where the hills were spaced nine inches apart with two plants to the hill. On the unthinned plats, the best yields was secured from the 16-inch spacing. The lowest yields were secured from plats where the stand was less than 20,000 plants or more than 40,000 plants per acre. The months of July, August and September, 1930, were very dry and plants grew only to a height of 12 to 16 inches, but were very heavily fruited, as shown by the high yields.

RESULTS OF COTTON SPACING EXPERIMENT AT PIEDMONT BRANCH STATION, 1930

Distance Between Hills— Inches	Plants per Hill	Actual Plants per 100 Feet	Plants per 100 Feet for Perfect Stand	Yield of Seed Cotton per Acre—Lbs.	
				First Picking	Total
9	2.....	243	265	848	1522
12	2.....	184	200	735	1433
12	Not thinned.....	289	.....	720	1372
16	2.....	140	150	690	1320
16	Not thinned.....	224	.....	795	1485
20	2.....	116	120	682	1365
20	Not thinned.....	185	.....	780	1440

**Cotton Varieties.** Results of an experiment conducted on Davidson clay loam in Rowan County given below show Mexican to be the highest yielder of lint cotton followed by Cleveland 884-4. Carolina Foster led in total value per acre, due to a larger premium credited for 1-3/16-inch staple.

## COTTON VARIETY EXPERIMENT

On Farm of J. F. Fisher, Salisbury, Rowan County—1930

Variety	Yield of Lint— Pounds per Acre	Per Cent Lint	Staple Length— Inches	Bolls Per Lb. Seed Cotton	Value per Acre	Price per Lb. Lint— Cents
Mexican (Fisher).....	338	33.9	1	66	\$41.23	10.05
Wilson Cleveland.....	312	34.2	7/8	77	34.84	9.05
Humco Cleveland 20-3.....	317	34.0	31/32	68	38.64	10.05
Coker Cleveland 884-4.....	360	34.5	1—1/16	67	45.49	10.55
Mexican No. 58.....	383	34.1	1—1/16	61	48.56	10.55
Mexican No. 128.....	373	34.5	1—1/16	60	47.13	10.55
Carolina Foster No. 4.....	359	33.3	1—3/16	73	52.04	12.30
Coker Foster No. 6.....	338	33.0	1—1/8	91	44.88	11.05

In tests on Coastal Plain soils in Hoke and Scotland counties the Foster varieties led in money value per acre followed by Clevelands 884 and 5, and Mexican. The best varieties in the inch-and-better group have consistently produced greater money values per acre than the shorter cottons.

**Wilt Resistant Varieties.** Fusarium wilt seldom occurs except in the Coastal Plain area of the State and is usually confined to the Norfolk and Hoffman series of soil. Infestation is worse on the coarse sandy types than on the loams of these series. Results of experiments conducted in Wayne, Robeson, Scotland and Richmond counties show that Rhyne's Cook, Dixie 14, Cleve-wilt and Dixie Triumph are highly resistant to this disease. Super-seven is quite resistant on most soils, but on some soils, particularly where nematodes are very prevalent, the percentage of wilted plants is rather high. The Mexican variety is semi-wilt resistant and also seems to be somewhat tolerant of nematodes. During June and July the percentage of infected plants was only slightly higher than was found in the highly resistant varieties. Later in the season a larger percentage of the plants showed infection as indicated by the discoloration of the stems, but many of these infected plants held their leaves until a fair crop of bolls were matured, while other varieties usually shed their leaves and died soon after becoming infected. The Cleveland varieties and strains are usually very susceptible. None of the varieties tested were free from nematode injury, but considerable difference was noted. The roots of Super-seven and the Clevelands were a complete mass of knots, while Rhyne's Cook and Mexican showed the least injury. Although Rhyne's Cook is highly resistant to wilt and partially resistant to or tolerant of nematodes, it is not a desirable variety, due to its very short staple,  $\frac{3}{4}$ -to  $\frac{7}{8}$ -inch.

## PEANUT EXPERIMENTS

Variety experiments, spacing tests, and selection for higher yields and better quality are being conducted at the Upper Coastal Plain Branch Station. The soil type is Norfolk sandy loam. Both yields and quality were poor in 1930 as compared with 1929, due to the very dry season. The total rainfall from July 20 to October 11 was only 1.30 inches.

**Peanut Variety Experiment.** The relative yield of the different varieties under experiment during 1929 and 1930 showed considerable varia-

tion with the exception of the North Carolina Bunch which has a slightly smaller pod than the Virginia Bunch, the pods having less veination and are less constricted between the seed. This variety produced the highest yield in 1930, and next to the highest in 1929. The Jumbo Runner led in percentage of handpicks during both years, followed by the Virginia Bunch. The shelling percentage, which determined the class, was slightly lower in 1930 than in 1929. During unfavorable seasons the smaller podded varieties seem to fill better than the large podded varieties. The Spanish were well filled and so were the North Carolina Bunch, while the Virginia Bunch and Jumbo Runner produced many pops. Most of these pops were blown out by the peanut picker, and therefore the percentage of handpicks and shelling percentages shown in the following table are only slightly lower than for 1929.

PEANUT VARIETY EXPERIMENT

Variety	Yield Nuts — Lbs. per Acre		Percent of Handpicks		Shelling Percent	U. S. Grade and Class	
	1930	1929	Jumbo	Fancy	Age	Grade	Class
Jumbo Runner.....	1120	1440	48.5	10.5	66.5	1	A
Virginia Bunch (Hancock)....	1160	1485	23.0	27.8	64.1	2	B
Virginia Bunch (McDaniel)...	1140		21.4	19.0	63.9	2	B
Virginia Bunch (Powell).....	1140		22.0	19.8	63.6	2	B
North Carolina Bunch.....	1220	1770	12.2	16.9	63.6	5	B
Improved Spanish 2B.....	960	1830			69.0	1*	
Macspan.....	620				69.0	1*	

\*U. S. Grades for Spanish peanuts.

**Peanut Spacing Experiment.** Both the Virginia Bunch and Jumbo varieties were used in the spacing experiments. With the Virginia Bunch, hills 8 inches apart and 2 plants to the hill, and 4 inches apart with one plant to the hill gave the largest total yield of nuts, followed by 12-inch spacing, 2 plants to the hill. However, the quality secured from the 4-inch spacing was not as good, grading No. 5 against No. 2 for the 8- and 12-inch spacing. The greatest number of pounds of Jumbo and Fancy handpicks and the most large shelled nuts per acre were secured from 8-inch spacing, 2 plants to the hill. It appeared that the 8- and 12-inch spacing caused more of a determinate growth than was secured on the 16-inch spacing. The pods were better filled out and there were fewer pops.

The 4-inch spacing was found to be entirely too close for the Jumbo Runner during a dry season, both the yield and quality being low. The largest total yield and also the largest amount of handpicks were secured from 8- and 12-inch spacings.

**Peanut Breeding.** Selection work for higher yield and better quality is being carried on with the Virginia Bunch variety. More than 100 individual plant selections secured from various fields in eastern North Carolina were grown during 1930. Some of these showed considerable promise in increased yield and in better quality. Twenty of these are being grown in larger plats for comparison during the season of 1931.

## EXPERIMENTS WITH SOYBEANS, LESPEDEZA AND CROTALARIA

**Soybean Varieties.** Varieties which have shown the greatest promise over a period of several years, new varieties and recent importations were included in variety tests conducted at the Coastal Plain and Blackland Branch Stations during the year. Considering both yield and quality, the Otootan and Laredo varieties continue to show up best for hay at the Coastal Plain Branch Station. In seed production, the Herman, Tokyo and Mammoth Yellow were best. These last three with Biloxi are best adapted for pasture, as they supply early, medium and late pasturage. The seed of the Biloxi variety do not pop out and they will furnish pasturage for hogs and cattle through December, January and perhaps February. A new importation (No. 71597) shows considerable promise as a hay variety and is also a good seed producer.

**Soybean Breeding.** A yellow seeded Biloxi hybrid has been isolated after several years of selection work. It is uniform in plant and seed characters and is non-shattering.

Selection work for a non-shattering character, higher yield and better quality of seed is in progress with the Mammoth Yellow variety.

**Lespedeza.** A variety test conducted at the Coastal Plain Branch Station has given the following yields of hay per acre:

## HAY YIELDS OF LESPEDEZA VARIETIES

Tennessee No. 76	2,533 lbs.
Kobe	2,840 lbs.
Common	1,400 lbs.
Korean	1,130 lbs.

**Crotalaria.** The species of this legume making the best growth and showing the most promise for soil improvement purposes at the Coastal Plain Branch Station during both 1929 and 1930 are *spectabilis*, *incana* and *striata*. The *incana* and *striata* species produced a large amount of seed in 1929, but very few in 1930, due to a very dry spring which caused late germination. The *spectabilis* produced some mature seed in 1929, but none in 1930.

## COOPERATIVE LEGUME WORK WITH THE FEDERAL BUREAU OF PLANT INDUSTRY

**Alfalfa.** Variety experiments have been seeded each fall, beginning with 1927. These experiments include the Common variety from various sources, Grimm, Hairy Peruvian, Ontario Variegated, and other varieties. Also seed from France, Italy, Hungary, Turkestan, Argentine and Africa are included in the test. Good stands were secured during all four years. During the winter of 1927-28, considerable winter-killing occurred on certain plats seeded during the fall of 1927. These plats were Hairy Peruvian, Arizona Common and three lots from Africa. These same varieties and seed from Argentine seeded in September 1929 were badly killed during the winter of 1929-30. Very little winter killing occurred on any varieties or sources after the plants were one year old. Seed of the Common variety grown in Utah, the Dakotas and Kansas have given best results. Grimm was very good. The lots tested from France and Italy have likewise given good results.



**Soybean Varieties.** Experiments, in which two late and 18 early and medium early varieties were used, have been in progress since 1929 at the Piedmont Station. Records are secured on yields of seed and hay, earliness, and type of plant.

**Lespedeza.** Variety, rate, date, time of cutting and rotation experiments were begun at the Piedmont and Coastal Plain Branch Stations in the spring of 1931.

**Crotalaria.** Tests of different species of this legume for yields of seed and growth for soil improvement, date of seeding and value in rotations were started at the Coastal Plain Branch Station farm in the spring of 1931.

### CEREAL EXPERIMENTS

The work in the improvement of cereals for the year has made slow but steady progress. Accumulated data on the different projects only is reported at this time.

**Corn.** The present season ended a five-year period of corn variety experiments which have been conducted simultaneously at the Mountain, Piedmont and Central Station farms. In the experiments on the Mountain farm, Big Corn, Holcombe's Prolific, Southern Beauty, Indian Chief, Jarvis' Golden Prolific and Biggs' Two-ear, have led in the order named. These tests were conducted on fertile moist bottomlands (Toxaway loam). These conditions seem to favor the single eared types of corn when based on field weights at harvest time.

Based on air-dry yields of the past three years, the yields of sound corn of the different varieties have been in the following order: Holcombe's Prolific, Big Corn, Southern Beauty, Biggs' Two-ear, Jarvis' Golden Prolific and Indian Chief. Holcombe's Prolific, Southern Beauty and Biggs' Two-ear were found to be the leading prolific white eared varieties for this section. Big Corn is the best adapted of the large single eared late maturing varieties. Jarvis and Indian Chief are the two leading yellow varieties. The two varieties lowest in average yield were Hickory King and Shoaf's Prolific in the order named.

In the experiments at the Piedmont farm for the same period, Weekley's Improved, Jarvis' Golden Prolific, Big Corn, Latham's Double, Southern Beauty, Indian Chief and Cocke's Prolific have yielded highest in the order named, while Shoaf's Prolific was the lowest yielder. According to these results, Weekley's Improved and Jarvis Golden Prolific, the first a white and the second a yellow variety, are the two leading prolific corns for Piedmont Carolina. Big Corn, Latham's Double and Southern Beauty are also well adapted to the conditions obtaining here.

In tests conducted at the Central farm for the same period, Weekley's Improved, Latham's Double and Cocke's Prolific were found to be the leading white eared varieties of the prolific type. Indian Chief and Jarvis' Prolific are the leading yellow varieties, while Highland Horse Tooth is the leading single eared variety.

At the Coastal Plain and at the Blackland Branch Station farms, variety tests are being run with the object of finding a yellow variety which will be well adapted to these sections and which will yield equally as well or better than the leading white eared varieties now being grown.



**Wheat.** The present season ended variety tests for 9-year periods at both the Piedmont and Mountain farms. At both farms Fulcaster, or some improved strain of it, made the largest yields. In the comparison of smooth wheats, Gleason led at the Piedmont farm, and Leap's Prolific did best on the Mountain farm. To those growers who prefer a smooth wheat, Gleason is recommended for the Piedmont area, and Leap's Prolific for the mountains. Purple Straw, or some strain of it, is recommended as a good early wheat. Redhart and Marette's 40-to-1, selections from the Red May, are excellent varieties. Early varieties, however, have not generally yielded as well as the later maturing varieties, provided the latter escape rust attack.

Improvement of wheat varieties, or the development of new ones, by field selection has now been in progress for two years at the Piedmont farm. Head selections are made in the field and are planted in 5-foot rows. The most promising of these selections are harvested and planted in 16-foot rows. These rows are harvested and their yields carefully noted. The best of these are selected and repeated in 16-foot rows. Constant elimination and the seeding of the best in replicated rows is continued until the highest yielding strains are isolated. These are then seeded in the variety test and compared for yield with the highest yielding varieties being grown at the farm. This season 400 selections from local varieties of wheat and rye were grown on the Piedmont farm, and 1,200 strains of wheat were tried out in cooperation with the Federal Bureau of Plant Industry. The best of these were saved and prepared for retrial during the coming season. Ten promising strains were grown in small replicated plats at the Mountain farm. A trial of the four best of these strains is to be continued the coming season. Many promising strains have been observed in these plantings.

**Oat Varieties.** The main object of the oat work is to find a variety that will withstand the extremes of winter weather. The Lee variety has proven the best so far for this purpose at the Piedmont farm. Thirty-one strains of the variety, developed by the Federal Division of Cereal Crops and Diseases, are being tried out at the Piedmont farm for winter hardiness. The Fulghum variety has proven a high-yielding variety, but is subject to winter-killing in the Piedmont region. Only spring-sown oats are grown on the Mountain farm, and of the several varieties tried, the Fulghum has proven the highest yielder. Burt and Richland are standard spring oats and have made fair yields. Tests are being conducted on both the Coastal Plain and Blackland Branch Station farms for hay yields. As a result of two years' work, Lee, Appler, and Norton have been the highest yielders at the Coastal Plain farm. At the Blackland farm the Burt and the Victory have led in the spring sowings.

**Rye.** The only rye work now being carried on, other than the selection work located mainly at the Piedmont farm, is a comparative test of Common and Rosen rye at the Mountain farm. From three years' results the Rosen variety has led in yield of grain for two of the seasons.

**Intercropping of Soybeans and Corn.** Intercropping corn and soybeans is one of the common practices of North Carolina farmers. These two crops are planted at the same time, either in alternate hills or alternate rows. To check up on this practice a series of tests were begun in the

spring of 1930 on both the Coastal Plain and Mountain Branch Stations. Four 1/10-acre plats are devoted to each series of experiments. The plats were planted as follows: (1) All corn; (2) corn and beans planted in alternate hills; (3) corn and beans in alternate rows; and (4) all beans.

On the Coastal Plain Branch Station, the all-corn plat yielded at the rate of 44.0 bushels per acre. The presence of the beans in the alternate hill plat reduced the corn yield to 35.8 bushels per acre, the loss in the corn yield due to the soybeans being 8.2 bushels, or 18.6 percent. To offset this loss in yield of corn, 8.8 bushels of beans were produced. When the corn was planted in alternate rows with soybeans, a loss of 11.2 bushels, or 25.4 percent in yield of corn was sustained which was offset by a yield of 13.5 bushels of beans per acre. The all soybean plat yielded at the rate of 28.3 bushels of beans. As the beans planted in alternate rows with corn yielded only 13.5 bushels per acre, there was a loss of 14.8 bushels, or 52.5 percent by being combined with the corn. This loss of beans was offset by a yield of 32.8 bushels of corn per acre. The presence of corn in the alternate-hill plat reduced the yield of beans 19.5 bushels per acre, or 68.8 percent. This heavy loss of beans was offset by a yield of 35.8 bushels of corn per acre.

The same general results were obtained on the Mountain Branch Station. Here, there was a loss of 5.86 bushels, or 10.4 percent in yield of corn in the alternate-hill plat from the yield of the all-corn plat. This loss was offset by a production of 7.5 bushels of beans per acre. The presence of beans in the alternate-row plats reduced the corn yield 19.0 bushels, or 33.7 percent. Twenty-six and six-tenths bushels of beans offset this loss. The all-bean plat yielded 30.8 bushels of beans per acre; the alternate-row plat, 26.6 bushels, a loss of 4.2 bushels, or 12.1 percent. The presence of the corn in the alternate-hill plat reduced the yield of beans 23.2 bushels, or 75.6 percent per acre. To balance this heavy loss of beans, 50.42 bushels of corn were produced.

### COTTON FIBER STUDIES

In cooperation with the Office of Cotton, Rubber and Other Tropical Plants of the Federal Bureau of Plant Industry, the source and care of cotton-planting seed in relation to the length of staple produced was studied on 216 North Carolina farms during the fall of 1930. The effect of the source and care of planting-seed on the uniformity of staple and the yield of cotton was also noted. Four widely separated gin areas were selected for this study in order to secure different soil and climatic conditions and variations in the method of selecting and caring for seed stocks. Samples were taken and the history was recorded of the varieties grown on the 216 farms. Results of this work have been published in Technical Bulletin No. 42. These studies are being continued.

#### Drag

Studies concerning the influence of drag, or the clinging power of cotton fibers upon the yarn quality have been reported in Technical Bulletin No. 33. Further work has been done along this line.

In 1927 two varieties of cotton (Mexican 6-1-9 and Acala 8-1-3) were chosen for testing purposes because they were of similar staple length

and showed a significant difference in drag. They were grown, harvested, ginned and manufactured under similar conditions.

Three samples were taken from each lot of cotton and submitted to the Appeal Board of Review Examiners, of the U. S. Department of Agriculture. Their classification showed no difference in the two cottons except for staple length, the Acala 8-1-3 being classed slightly longer than the Mexican 6-1-9. The classers apparently recognized no difference in the character of the samples.

Measurements of physical properties of the fibers in the cottons tested showed the following differences which are listed below:

Measurement of length on the mechanical sorter showed that the Mexican cotton was slightly longer and more uniform in length than the Acala cotton. The fiber weight per inch and the approximate diameter of mercerized fibers and of green fibers of the Mexican variety were greater than that of the Acala variety. The drag of the Mexican variety was less than that of the Acala variety.

The cottons were spun into yarns at Clemson College, S. C., under the supervision of H. H. Willis, Senior Cotton Technologist, with the Bureau of Agricultural Economics of the U. S. Department of Agriculture. The Mexican variety contained less waste in the spinning test than did the Acala. Both lots of cotton produced yarns which appeared to be about normal in uniformity and no difficulty was encountered during the spinning processes. The two lots of cotton produced yarns of high breaking strength for their particular staple lengths. The yarn spun from the Mexican cotton was noticeably stronger than that spun from the Acala. It is important to note that the cotton which was found to be weaker in drag produced the stronger yarn. This result substantiates findings of a similar nature.

### Cell-Wall Diameter

Further studies have been made of cell-wall or fiber diameter in varieties and strains of cotton. Previous results have indicated that in a comparison of the fiber diameter of cotton strains or varieties, having a longer length of fiber, with strains or varieties having a shorter length of fiber, an increasing length was associated with a decreasing diameter, and vice versa.

During the past year samples from 17 strains from several leading Arkansas varieties were obtained from the Arkansas Station. The average diameter of each strain was then calculated by making sufficient measurements. A comparison of the diameter of ten Rowden strain studies showed that as a general rule an increasing length was associated with a decreasing diameter. However, some of the strains of this variety having similar staple lengths showed significant differences in fiber diameter, and the same was true of the three Acala strains surveyed. The results indicate the possibility of selecting cotton for fineness. The data thus far obtained on fiber diameter show that, as a rule, a finer diameter is associated with a longer length, but that there are exceptions which might be used to advantage by the plant breeder.

### Place Effect

Some studies are being made concerning the influence of place on the

physical properties of the cotton fiber. Place effect, as used here, embraces the soil and climatic factors involved in the production of cotton.

In 1929 a strain of the Mexican variety was planted at five places on four different soil types. Plats at all of the places were fertilized with 600 pounds of an 8-4-4 fertilizer per acre. First and second pickings were made at three places, while a second picking only was obtained at two. Thus far only the length of staple of the samples taken has been measured. This has been done carefully on the seed and also in samples ginned on a small roller gin. A record of the rainfall was kept at three of the fields—Central, Piedmont and Upper Coastal Plain Station farms. The following is a summary of the results obtained:

PLACE EFFECT ON THE LENGTH OF COTTON FIBER—1929

Location	Soil Type	Length of Staple in Inches			
		1st Picking	2nd Picking	Average	Differences
Upper Coastal Plain Branch Station	Norfolk sandy loam	1-1/32	1-1/16—	1-1/16—	In favor of 2nd picking (1/32)
J. P. Lucas Farm, Lucama, N. C.	Marlboro sandy loam		1-1/32	1-1/32	.....
Central Station	Cecil clay loam	1-1/16	1	1-1/32	.....
Piedmont Branch Station	Cecil clay loam		1-1/16	1-1/16	In favor of 1st Picking (1/16)
Davie County	Appling sandy loam	1-1/32	1-3/32	1-1/16—	In favor of 2nd Picking (1/16)

The data in the above table do not indicate any significant difference in the average length of staple grown at the five places. Columns 5 and 6 show that staple from the second picking was longer at the Upper Coastal Plain farm and in Davie County, and that the reverse was true at the Central Station farm. Therefore, it is not probable that the average differences given in column 5 are significant. It is interesting to note that there is a difference of 1/16-inch between the first and second pickings at the Central Station farm and also in Davie County. It appears, then, that each picking should be ginned by itself in order to market to the best advantage and receive a premium for length and uniformity of length.

#### Effect of Fertilizer

The influence of varying fertilizer formulas on the physical properties of cotton fiber is being studied at various points in the State. Considerable data have been obtained since 1927, when the investigations were started. No definite conclusions can be drawn, however, at this time. Results to date indicate that fertilization has little or no influence on length, but that it may exert an important influence on fiber weight and perhaps on other properties of the fiber.

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Head, Department of Agronomy.



## RESEARCH IN SOIL EROSION

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The Statesville Soil Erosion Farm was established in the spring of 1930. It is being operated by the Bureau of Chemistry and Soils and the Bureau of Agricultural Engineering, of the U. S. Department of Agriculture and the North Carolina Department of Agriculture and Experiment Station. This farm is composed of a number of small farms and comprises 304 acres. Of these 304 acres, there is about one-half that is tillable.

The soil on the farm is composed mainly of the Cecil series, although there are some small areas of the Davidson, Mecklenburg, Appling, and Iredell series. Of the Cecil, the sandy clay loam is the predominating type.

The topography of the farm, as a whole, is probably a little more rolling and cut up than is typical of most Piedmont farms. Certain fields that have been in cultivation for some years are quite steep and no previous effort had been made to prevent runoff, and on these areas the surface is practically all washed away leaving only the red clay subsoil. On a few of the fields an effort was made to do some terracing, but it was not adequate to take care of all the runoff. The farm, as a whole, is badly in need of management to retain what soil is left and to prevent further runoff. The untillable area is made up of timber land and rough gullied land. The timber land has a growth of pine, oak, dogwood, etc., on it. The farm has the reputation in this locality of being in a rundown condition.

In taking over this farm it was not possible to get possession of the whole farm until after the crop year of 1930, because it was purchased so late in the season that some of the farmers had their 1930 crops planted and fertilized. Arrangements were made with these farmers to either purchase their crop or that they should retain the use of the field until the crop was harvested.

During the late summer and fall plans were made for the experiments to be conducted. These were to start January 1, or with the coming crop year. These arrangements were made in conference with officials of the North Carolina Experiment Station and with members of the Bureau of Chemistry and Soils and the Bureau of Agricultural Engineering. At these conferences methods for handling the farm were also worked out. These discussions included the crops to be planted on various fields, the variety to be planted, method of fertilization, and the management of the crops. The experiments that were to be conducted by the Bureau of Chemistry and Soils were gone over carefully and the crops to be planted in the various plots were given consideration, the various rotations suitable for this locality were also taken up and discussed. The management of these plots will be as similar to the farmer's methods as small plots will permit.

The projects that were conducted as the Statesville Soil Erosion Farm by the Bureau of Chemistry and Soils during the fiscal year 1930-31 are:

1. To study the effect of various crops and soil conditions on runoff water and erosion material.
2. To determine the variation in runoff and the amount of erosion on a wooded area, a burned over area and on newly cleared ground.



3. To compare the amount of runoff and the yield from land that has been eroded and from land that has not been eroded.
4. To determine the amount of runoff and the intensity of rainfall to cause noticeable erosion.
5. To study the runoff water and eroded material from controlled plots.
6. To prevent gullies that are already formed from creeping further into the land.
7. To determine the amount of soil that is saved by the construction of a dam across a gully at the end of a field.
8. To prevent further erosion and to improve soil fertility on land that is eroding but where the erosion has not progressed sufficiently far so that the land cannot be used for a cultivated crop.
9. To reclaim land that has already been severely eroded.
10. To determine the moisture content of soils in different plots and in various locations on the farm.

The construction of plots and tanks to make a study of the runoff have been completed with the exception of some details and they have been in operation since January 1, 1931. There are 12 plots in this set-up, 10 of them being 1/100 acre in size, one of them 1/50 acre, and one 1/200 acre. The soil has a very uniform slope of 10 percent, and is a Cecil sandy clay loam and has eroded very little. Each plot is enclosed by a strip of sheet metal. The tanks are made of water tight concrete, and each tank from the 1/100 acre plots will hold about 1,500 gallons. The tanks from the 1/50 and 1/200 acre plots are sized accordingly—to take care of the runoff from their respective plots. Every tank is calibrated so that the contents can be measured from a gauge. Each tank, with the exception of the 1/200 acre one, is equipped with a water tight man-hole in the back so that the eroded material can be removed and to provide an entrance to the tanks without going in through the man-hole in the roof. A tile drain was constructed in the soil along the front part of the tanks to take care of the excess water that might accumulate with the tanks as a sort of dam or as an obstruction to the natural flow of water through the soil. This drain empties into the woods and was put in at a depth of about 3 ½ feet at the southwest end, and about 4 ½ feet at the northeast end. A tile drain was also constructed to carry runoff water away from the tanks after the samples have been taken. This also empties into the woods at a distance of about 50 or 60 feet away from the tanks.

The plots were all planted to the crops at the regular planting season. The surface soil was removed from the plots that are taking the place of eroded plots in this experiment. The plots received the following treatment (all plots except where specified, are 1/100 acre in size):

- |      |     |   |
|------|-----|---|
| Plot | 1.  | Desurfaced. Continuous cotton.  |
| Plot | 2.  | Desurfaced. In rotation of corn and cotton  |
| &    | 3.  | (rye and vetch to be planted after the cotton and corn, and are to be plowed under in the spring. |
| Plot | 4.  | Bare. Fallow.   |
| Plot | 5.  | & 6, & 7, & 8. In four-year rotation.   |
| Plot | 5.  | Corn.   |
| Plot | 6.  | Wheat (lespedeza planted in wheat).   |
| Plot | 7.  | Lespedeza.  |
| Plot | 8.  | Cotton (rye and vetch planted in the fall).   |
| Plot | 9.  | Standard pasture mixture (permanent).   |
| Plot | 10. | Continuous cotton.  |
| Plot | 11. | Continuous cotton (1/50 acre).  |
| Plot | 12. | Continuous cotton (1/200 acre).   |

All these plots were planted in the spring of 1931, with the exception of the wheat which will be planted in the fall. The crops were planted on the contours. These plots will be under absolutely controlled conditions, as far as runoff and erosion are concerned. The cotton plants were thinned out so that each plot contained the same number of plants:

The plots in the wooded areas have the excavation completed but the tanks will not be installed until the next fiscal year.

On some land that is badly eroded an effort is being made to reclaim it. The area selected for this work was a series of gullies that are just east of the tank plots. This area is severely eroded and the gullies are shoulder deep in a number of places, and at the extreme outlet they are from 8 to 10 feet deep. The area from gully to gully is quite narrow, some places not more than 12 feet. This was cleared about 75 years ago but was not in cultivation long when it was allowed to grow up. Now it is so badly eroded that there is not enough surface soil left for the forest seed to germinate. This area is surrounded by woods and has plenty of chance to reseed itself if the seed had an opportunity to grow. When a seedling does get started it does not have the protection or food necessary for proper and sustained growth. On this area it was decided to try some different methods of reclamation that were economical and practical with the hope that they would be effective.

- Area 1.—Brush was scattered between the gullies just thick enough to give a good covering to the area. This brush consisted of branches of trees, pine shats, dead branches and leaves collected from the nearby woods. It is the intention here to allow nature to do the reseeding and to let the brush hold back further washing.
- Area 2.—50 pine seedlings were planted between the gullies. These seedlings were planted close (6'x6') up and down the ridge.
- Area 3.—50 black locusts seedlings were planted as in Area 2. (In all probability one-half will be given a light covering of brush to protect the seedlings and the other half will be left just as it is.)
- Area 4.—Grasses that do well on eroded soil, such as wild lespedeza, will be planted.
- Area 5.—No effort will be made to reclaim it, but just allow the erosion to follow its natural course and use it as a check for the other plots.

An effort is being made to find some fairly accurate means of measuring the results obtained from these areas. The slope on this eroded area is about 18 to 20 percent.

In order to determine the amount of soil that is saved by dams, one was constructed out of the soil that was excavated for the tanks. It was placed across the rather large gully at the end of the field and was constructed so that it was higher in the center and lower at the ends so the water could get around the side if it should fill up. Stakes were placed at 10 feet intervals all through the area and they were marked so that a record could be kept of the amount of soil deposited. This dam has filled up so much in the first six months of 1931 that in order to protect the dam from washing away it will be necessary to adopt some other means of keeping the runoff from this area. It is planned to construct a small

terrace around the edge of the gully and to plant kudzu all over the slope of it.

To study the effect of crops and rotations on erosion control, an area of land was measured off and a number of plots were established and planted to various crops and rotations. The plots were planted in the spring of 1931 and are on the Cecil sandy clay loam. This set of plots are 1/40 acre in size, and are to run in duplicate series, each series consisting of 20 plots. The individual plots are to be separated by a 2-foot strip of grass and each series is to be separated by a 20-foot strip. These crops have been fertilized with the amount and kind recommended by the North Carolina Experiment Station. All legumes have been inoculated and the plots where sweet clover was planted have been limed according to the requirements of the soil.

Some experiments have been planned with the Bureau of Agricultural Engineering, such as taking moisture samples from terraced and unterraced land. Some work with the drops on land that is terraced and unterraced is also planned.

Besides planning the foregoing experiments and getting them under way, a shed 12'x50' was constructed as an implement building. This was built by the regular farm help and from lumber sawed on the farm. Some land was cleared and the underbrush removed, a number of dams were built in various gullies to retard the water from overflowing some good land. A soil and erosion survey was made, but the map has not been completed.

Besides the experimental work, general farm work was carried on. Approximately 65 acres were planted to lespedeza, about 75 acres to soybeans (broadcast), and 8 acres to cotton. The seed were of the best type and the amount and kind of fertilizers were those recommended by the North Carolina Experiment Station.

Various buildings on the farm were given a new coat of paint, and a number of repairs were made on these buildings.

J. M. SNYDER,  
*Scientist in Soil Erosion.*

### SOIL EROSION RESEARCH

The first year's work of the Bureau of Agricultural Engineering may be briefly described as one of organization and preparation. Five rough and independent groups of clearings and woods had to be consolidated into one farm unit, and the rough edges knocked off before the experimental program (which later had also to be worked out) could be instituted. Machinery had to be secured, seed and fertilizer purchased, oil and gas contracts let, and arrangements made with tenants then in possession for use of the land. A foreman to supervise farming operations was engaged and an office for carrying on the numerous details of the work was established.

Work was begun on May 1. By the 23rd, fifteen acres had been disced, harrowed, worked over with a corrugated roller and planted to cotton. By the end of the month, thirty-six additional acres had been prepared and drilled to soybeans; the edges of all fields had been cleared back of small growth; about six acres of small pines cleared from one field, and all the smaller stumps in another field pulled with tractor and cable.

During the following month all available land was plowed and seeded to soybeans as a soil improvement crop. Farm work thereafter during the summer and fall consisted of the necessary cultivation of these crops; their harvesting and the planting of winter cover crops.

The major projects during the summer and fall were the making of boundary and topographic surveys of the farm property. Concrete markers were set at all land corners (many of which had been lost and had to be re-established) after which the lines were surveyed. This work was carried out with a high degree of precision. Following the survey acreages were computed and descriptions of the property prepared for use in drawing up deeds of conveyance.

The topographic survey gave data for the drawing of a map to a scale of 1 inch to 100 feet with contour intervals of two feet. Elevations were connected with U. S. G. S. levels with sea level as a datum. Only the cleared area was mapped, though the survey covered the wooded areas as well. With this map as a basis, the plan of experiments was worked out, as outlined later in this report.

Other work during the summer and fall consisted in the building of two large log soil saving dams, several large brush dams and about 150 small brush dams to check field washing and gully formation. Large quantities of cinders and about 250 cubic yards of sand were hauled and distributed as surfacing over the road leading to farm headquarters after necessary grading was done. Practically all of the buildings on the farm were in a poor state of repair and these were put into better condition. A 75'x16' implement shed with tool house was also built, practically all of the lumber used in construction and repair being sawed from trees felled on the farm during clearing operations. About 1,200 pounds of dynamite were used in clearing fields of stumps to make way for terrace construction.

During the second half of the year the principal work carried on, in addition to planting spring crops, was the construction of  $9\frac{3}{4}$  miles of terraces. These ranged from 18 to 26 feet in width and from 12 to 30 inches in height. Detailed records were kept of tractor and man hours and of the amount of earth moved in terrace construction. In addition the topographic survey of the wooded area was completed, some 600 pine and locust seedlings were set out on eroded areas, seven flumes were set at the ends of terraces for measurement of water losses and work was started on the construction of silt boxes for these flumes.

### OUTLINE OF EXPERIMENTS

The experimental work to be done by this Bureau will consist principally in studying on a field scale the effects of various mechanical and engineering structures on erosion and water control, and the relationship of these methods to the use of modern machinery in working the land. Fifteen experiments are planned, the first eleven of which deal with terracing directly. The plan calls for the following studies:

1. To determine the most satisfactory spacing of terraces on steep slopes.
2. To determine the most satisfactory spacing of terraces on moderate slopes.
3. To determine the most satisfactory grade for short terraces.
4. To determine the most satisfactory spacing for long graded terraces.



5. To determine the most satisfactory uniform grade for terraces.
6. To determine the most satisfactory length to build terraces for the particular fall, vertical spacing, and land slope.
7. To determine the most satisfactory spacing for short level terraces and to determine the effect of length upon the satisfactory drainage of a level terrace channel.
8. To determine the effect upon crop yields of holding all the rainfall by level terraces with closed ends, and the possibility of retaining all the rainfall without overtopping such terraces.
9. To determine the effectiveness of and benefits derived from terracing from an economic standpoint as compared with farming where terracing is not practiced.
10. To obtain data on the cost of constructing terraces of different sizes and with different implements and to improve methods and develop better machinery for building terraces.
11. To study the design and operation of farm machinery over terraced lands and to determine the most satisfactory cross-section for terraces where machinery is used in farming operations.
12. To develop a cheap and effective method of checking erosion and filling gullies by means of check dams.
13. To determine the rate of soil movement down the slopes for terraced and unterraced land and for terraces with different spacing.
14. To obtain data on run-off and silt losses for terraced and unterraced watersheds under cultivation, and unterraced watersheds in timber and in pasture.
15. To determine the effectiveness of subsoiling in preventing erosion.

In general, equipment will be installed at the outlets of selected terraces and at the lower end of watersheds which will enable the water and soil losses to be accurately measured. Equipment has been devised by engineers of this Bureau for this purpose, namely: the Parshall flume and Ramser silt sampler. These measurements will be supplemented by field observations of wash between terraces, gully formation and of crop yields on comparable areas. The experimental plan will be revised and expanded from time to time as found necessary.

Considerable interest has been manifested throughout the year both locally and by residents of other Piedmont counties, in the work on the farm. Several bus and automobile tours organized by County Agents and vocational school instructors inspected the farm and visits of individual farmers was a matter of almost daily occurrence. It is expected that this interest will increase as the experimental installations are completed and the various studies are put into operation.

F. O. BARTEL,  
*Senior Drainage Engineer.*



# RESEARCH IN ANIMAL HUSBANDRY

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## BEEF CATTLE, SHEEP, AND SWINE INVESTIGATIONS

EARL H. HOSTETLER, *In Charge*

The research work in Animal Husbandry has been expanded during the past year to include the study of special problems on several privately owned farms in the eastern part of the State. This expansion was made possible through the aid furnished by the Animal Husbandry Division, United States Department of Agriculture, and we were thus able to secure the services of Professor L. I. Case, who is devoting his entire time to the study of beef cattle and related livestock problems in Eastern North Carolina.

### BEEF CATTLE PROJECTS

#### Quality of Meat—Blackland Station, Wenona

(In cooperation with Bureau of Animal Industry and other State Experiment Stations)

Fourteen grade Hereford and twelve native yearlings were fattened for 139 days on a ration of shelled corn, cottonseed meal and soybean hay, then shipped to Beltsville, Md., for slaughter and analysis. The grade animals required 38 pounds less shelled corn, 4 pounds less cottonseed meal and 52 pounds less soybean hay to produce one hundred pounds gain than the natives. They also made slightly greater daily gains.

After the carcasses had been graded it was found that the average grade was medium-good for the grade steers, native steers and native heifers, but had increased one sub-grade to high-grade for the grade heifers. The palatability and tenderness tests did not show any significant differences between the natives and grades.

#### 2. Vitamin A Studies—Central Station Farm

(In cooperation with Dr. J. O. Halverson)

Ten grade Shorthorn heifers that were dropped in March and April, 1930, were purchased in Ashe County for this work. One was slaughtered at the beginning of the feeding trial on November 10, 1930, and the other nine were started on the following rations: Calves Nos. 7 and 8 were given the basal ration consisting of 2 parts cottonseed meal, 1 part cottonseed hulls, and 1 part beet pulp; Nos. 9 and 10 received a mixture of equal parts of yellow corn, cottonseed meal, cottonseed hulls and beet pulp; Nos. 11 and 12 were fed the basal ration plus a daily allowance of cod liver oil; Nos. 13 and 14 received the basal ration to which 9.09 percent of alfalfa leaf meal had been added; No. 15 was given a full ration of white corn and soybean hay with the addition of one to two pounds of cottonseed meal daily. Calves 7, 8, 9, and 10 failed to reach satisfactory slaughter weights until cod liver oil had been added to their original rations.

The two calves, Nos. 11 and 12, fed the basal ration plus cod liver oil, and Nos. 13 and 14, receiving the basal ration with the addition of 9.09 percent of alfalfa leaf meal, have gained and improved in condition in a manner comparable with calf No. 15 that is being fed a standard fattening ration.

### 3. Comparison of Carbonaceous Roughages—Piedmont Branch Station, Statesville

The results with two-year old steers through a feeding period of 122 days, show that the group receiving ground wheat and cottonseed hulls made average daily gains of 2.16 pounds and the cost per one hundred pounds gain was \$14.92, while the cattle that were fed ground wheat and corn stover as roughage gained only 1.95 pounds per day on the average at a cost of \$15.56 per hundred pounds gain.

### 4. Value of Reeds (*Arundinaria tecta*) for Summer Pasture—Blackland Station, Wenona

Twenty-nine cows and sixteen calves were furnished ample reed pasture from May 9 to December 18 (233 days) and during this time the cows and calves gained respectively 2,299 pounds and 3,156 pounds. Fifteen yearling steers were also grazed on reed pasture and gained 2,148 pounds during a 194-day period from May 9 to November 19.

### 5. Value of Crop Gleanings for Wintering Cattle

#### A.—BLACKLAND STATION, WENONA

The gleanings from two corn fields from which the corn had been harvested, were used by the herd of beef cattle during the winter of 1930-31. The first field contained seventy-five acres of new ground corn that yielded only ten bushels per acre but carried twenty-nine cows and eighteen calves for 28 days. However, during this period the cows showed a loss of 53 pounds per head, while the calves lost an average of 29 pounds. The second field of forty acres, that had yielded thirty-nine bushels per acre, caused twenty-eight cows and seventeen calves to gain 49 and 32 pounds respectively per head during a 27-day period from January 15 to February 11.

#### B.—W. W. JARVIS' FARM, CURRITUCK COUNTY

Forty-nine head of cattle were carried on crop gleanings on this farm during the winter of 1930-31. The area used consisted of 89 acres of stalks from which an average of forty bushels of corn per acre had been harvested, and 65 acres of soybean stalks which had yielded 15 bushels of beans per acre. The cattle at the beginning of the wintering period consisted of 19 cows, 6 nursing calves, 1 two-year old steer, 17 mixed steer and heifer calves and yearlings. During the wintering period 6 more calves were dropped, making a total of 49 head. There was a total gain in weight from November 17 to March 10 of 2,825 pounds.

### 6. Pasture Studies

Pasture studies consisting mainly of fertilizer tests were started in the spring of 1931 on several farms in the Coastal Plains section of the State. The fertilizers were applied during March and April. The soil types were primarily fine and very fine sandy loams, and varied from quite acid (P.H. 4.3) to practically neutral (P.H. 6.8).

The results measured mainly by observation and population counts, indicate favorable results from complete fertilizer 8-4-4 and 16% superphosphate in relation to the growth and spread of lespedeza. Nitrate of

soda alone appears to have stimulated the growth of grasses but had the reverse effect on lespedeza. In all cases the difference seems to be in growth rather than population. No effects of lime are in evidence so far.

## **SHEEP PROJECTS**

### **1. Control of Stomach Worms by Sanitation—Central Station**

Twenty-four ewes in the Experiment Station flock were again divided into three equal groups and they and their lambs were treated as follows: Group 1 grazed on permanent pasture and the lambs drenched at 28-day intervals with nicotine sulphate; Group 2 also grazed on permanent pasture but the lambs were drenched every 14 days, and Group 3 was grazed on temporary pasture but the lambs were given no medical treatment to prevent damage from stomach worms.

The lambs in Group 3 made better gains, reached market weight at an earlier age and, those that were slaughtered, had fewer stomach worms than the lambs in either of the other two groups. The gains on the lambs were poorest in Group 2, although only slightly less than in Group 1, but due to a prolonged drouth during the grazing season the infestation from stomach worms was undoubtedly less than it would have been during a season of normal rainfall.

### **2. Control of Stomach Worms by Drenching—Piedmont Station, Statesville**

Ten lambs were divided into two equal groups and the feed was withheld from Group 1 for twenty hours before drenching and neither feed nor water was given to this group for five hours after drenching. Group 2 was taken off pasture and drenched immediately, then turned back on pasture without a fasting period. All lambs in each group were drenched at regular 14-day intervals from June 3 to October 20, 1930, and were allowed to graze on the same permanent pasture during this 139-day period. At the close of the trial the lambs in Group 2 were, on the average, 10 pounds heavier than those in Group 1, and the gains of the individual lambs in Group 2 were more uniform than those in Group 1.

### **3. Cost of Raising Lambs to Marketable Age—Upper Coastal Plain Station**

The flock at this station consisted of twelve mature ewes, five ewe lambs, and one pure-bred Dorset ram. The twelve mature ewes produced and raised fifteen lambs that were either sold for \$8.00 per cwt. or retained in the flock, and 140 pounds of wool was sold for 15 cents per pound.

The lack of cover crops for winter grazing aided in decreasing the profits this year to .54 cents per lamb, instead of \$5.37 which was the amount returned per ewe last year after the cost of the feed had been deducted.

### **4. Upgrading Native Eastern North Carolina Sheep—Central Station**

The results on this project during the past year were obtained from six native ewes, six first cross ewes and their fourteen lambs.

The influence of the pure-bred Shropshire ram was not only shown in the increased weight and better conformation of his daughters as com-

pared with their native dams, but the average weight of the fleece was increased from 3.29 pounds to 5.87 pounds and the length of the staple was increased from 2.29 inches to 2.62 inches.

## SWINE PROJECTS

### 1. Mineral Supplements

#### A.—SOW HERD—SWINE RESEARCH FARM

The sow herd was divided into two groups and both were fed the same grain mixture and grazed on comparable pasture, but Group 1 received in addition a mineral mixture composed of 10 pounds of calcitic limestone, 10 pounds of superphosphate and 2 pounds of salt, while Group 2 received a commercial mineral mixture.

During the fall of 1930 eight sows out of ten that had been bred, in Group 1 farrowed seventy-three pigs that had average birth weights of 2.35 pounds. These eight sows weaned fifty-two pigs that averaged 26.29 pounds when they were eight weeks old. There were ten sows bred in Group 2 and nine farrowed ninety-three pigs that had an average birth weight of 2.48 pounds. Fifty-five pigs were weaned at eight weeks of age from this group and weighed 1,474 pounds, or an average of 26.80 pounds per pig.

#### B.—FATTENING PIGS—COLLEGE FARM

Two separate trials were conducted during the past year in which different mineral mixtures were composed as supplements to a basal ration of shelled corn, fish meal three parts and alfalfa meal one part. The shelled corn, protein mixture, and mineral mixture was self fed free choice to each group. In both trials the pigs were divided into four equal groups with Group 1 being fed no mineral, Group 2 a mineral mixture composed of 10 pounds dolomitic limestone, 10 pounds superphosphate, and 2 pounds salt, Group 3 the same mineral mixture as Group 2 except that calcitic limestone was used instead of dolomitic, and Group 4 was fed a commercial mineral mixture.

Seventeen 42-pound pigs were used in the first trial. Their average daily gains and feed required to produce 100 pounds of gain were respectively 1.16, 1.11, 1.18, 1.17 and 391, 396, 370, and 404.

During the second trial twelve 69-pound pigs were used in each group. Their average daily gains and feed required to produce 100 pounds gain were respectively 1.52, 1.74, 1.78, 1.76 and 435, 394, 381, and 358.

### 2. Comparison of Protein Supplements

#### A.—CRAB MEAL VERSUS FISH MEAL—COLLEGE FARM

Crab meal was compared with fish meal, as a supplement to corn and mineral for fattening pigs, in two trials. In the first trial 103 pound pigs were fed for 61 days. The fish meal pigs required only 367 pounds of feed to produce 100 pounds gain while those receiving crab meal required 401 pounds. Three groups of 62 pound pigs were fed in the second trial for 62 days. The rations used were as follows: Group 1, corn meal, fish meal and mineral; Group 2, corn meal, crab meal one-half and cottonseed meal one-half, and mineral; and Group 3, corn meal, crab meal and mineral.



The addition of cottonseed meal for the pigs in Group 2 apparently improved the ration since the pigs in this group made an average daily gain of 1.13 pounds and only 452 pounds of feed were required to produce 100 pounds of gain instead of 833 pounds when crab meal alone was used.

**B.—FISH MEAL VERSUS EQUAL PARTS OF FISH MEAL, COTTONSEED MEAL, AND SOYBEAN OIL MEAL—BLACKLAND STATION**

Sixty-two 78-pound pigs were fed 77 days to continue the comparison of fish meal alone, with fish meal one-third, cottonseed meal one-third, and soybean oil meal one-third, as a protein supplement for fattening pigs.

The mixed protein supplement again gave better results than fish meal alone, in that, the fish meal pigs averaged 9 pounds lighter at the close of the trial and had consumed 411 pounds of feed per 100 pounds gain, instead of 378 pounds.

**C.—MENHADEN VERSUS HERRING FISH MEAL—SWINE RESEARCH FARM**

Menhaden fish meal, analyzing 55 percent protein, was compared with herring meal, analyzing 69 percent protein for fattening pigs. Ten 47-pound pigs were fed in each group for 106 days. The pigs receiving the meal containing the higher percentage of protein required only 348 pounds of feed to produce 100 pounds of gain instead of 369 pounds, but the rate of gain was approximately the same for both groups.

**3. White versus Yellow Corn for Fattening Pigs**

**A.—BLACKLAND STATION, WENONA**

Sixty-eight 111-pound pigs were divided into two equal groups and self fed, free choice for 63 days. Group 1 received white corn, fish meal one-half and cottonseed meal one-half and mineral, and Group 2 was fed the same feeds except that yellow corn was substituted for white.

Group 2 made an average daily gain of 2.07 pounds instead of 1.64 pounds and required 411 pounds of feed to produce 100 pounds gain instead of 433 pounds. The average profit per pig was \$1.80 greater in Group 2 than in Group 1.

**B.—SWINE RESEARCH FARM, RALEIGH**

(In cooperation with Dr. J. O. Halverson)

The second and third trials were completed during the past year in which pigs were fed individually a basal ration consisting of 90 pounds of white corn meal, 7 pounds of fish meal and 3 pounds of mineral mixture.

Four pigs, numbers 8, 9, 10, and 11, were used in the second trial. Pigs No. 8 and No. 11 were continued on the basal ration alone for 274 days and then killed, weighing respectively 122 pounds and 116 pounds. Neither of these pigs had eaten any feed for twenty-six days prior to death. Pig No. 9 was carried on the basal ration for 228 days after which time 6 pounds of alfalfa leaf meal was added to her ration. She weighed 130 pounds when changed to the basal-alfalfa-leaf meal ration and was slaughtered 108 days later, weighing 209 pounds. Pig No. 10 was fed the basal ration 200 days after which time yellow corn was substituted for the white. During the succeeding 136 days she increased in weight from 97 pounds to 242 pounds.

Six pigs, Nos. 12 to 17, were used in the third trial to study the effects of different supplements when fed with the basal ration throughout the feeding period. Pigs Nos. 12 and 13 received yellow corn instead of white corn, pigs Nos. 14 and 15 received the basal ration plus 6 pounds of alfalfa leaf meal, and pigs Nos. 16 and 17 received the basal ration plus one ounce of cod liver oil per pig daily. All pigs were fed individually on concrete floors for 159 days, then slaughtered after having gained respectively 188, 200, 194, 187, 192 and 187 pounds.

#### 4. Cottonseed Meal for Brood Sows—College Farm

The herd of twenty Berkshire and Tamworth sows was divided into two equal groups on February 1, 1930 and since that time each sow has been bred to farrow two litters per year and the pigs have been weaned when eight weeks of age. Group 1 has been fed a mixture of corn meal 60 pounds, ground oats 32 pounds, fish meal 8 pounds, and mineral 3 pounds, while the mixture for Group 2 has been corn meal 60 pounds, ground oats 28 pounds, cottonseed meal 9 pounds, fish meal 3 pounds, and mineral 3 pounds. Identical temporary pastures have been available for both groups of sows throughout the greater part of the year.

During the fall season 1930, the sows in Group 1 farrowed 80 and weaned 64 pigs with average birth weights of 2.9 pounds and average weaned weight of 34.6 pounds; while those in Group 2 farrowed 74 pigs with an average birth weight of 3.0 pounds and weaned 53 pigs with an average weight of 30.5 pounds.

Sixty-three pigs were farrowed and 47 weaned in Group 1 and 78 were farrowed and 66 weaned in Group 2 during the spring 1931 season. The average farrowing and weaning weights for Groups 1 and 2 were respectively 2.8, 35, 2.9 and 34.3 pounds.

#### 5. Utilization of Crops—Upper Coastal Plain Station

(In cooperation with Dr. H. B. Mann)

The three one-acre plats being used in this experiment were planted to corn and soybeans in the spring of 1930 but due to lack of rainfall practically none of the soybeans matured and the yield of corn was decreased so that Plat 1 yielded only 12.2 bushels, Plat 2 15.1 bushels, and Plat 3 11.1 bushels. The cost of producing the crop on each plat was \$16.00; corn was valued at \$1.00 per bushel and pork at 10 cents per pound. Therefore, Plats 1 and 3 showed a loss of \$3.80 and \$4.09 respectively, but Plat 2 showed a profit of \$3.86.

#### 6. Retarded Growth—Swine Research Farm

This project was outlined to study the effects of (a) feeding a limited ration to pigs until they reached a weight of 100 pounds when nine months of age, then full fed to slaughter; (b) full feeding from weaning to slaughter; (c) full feeding pigs to a weight of 225 pounds, then limiting the ration and slaughtering them after they had lost 18 percent of their live weight.

Pigs having initial weights of 51 pounds were used in both the limited and full fed groups. The feed consumed per unit of gain was approximately the same for both groups although the time required to reach a given weight was naturally less in the full fed group.

## 7. Permanent Pasture for Fattening Pigs—Swine Research Farm

Forty-five pigs were divided into three equal groups and full fed to compare dry lot feeding against pasture (orchard grass) and to compare one group on pasture, that was fed a ration satisfactory for dry lot feeding, against another group on similar pasture but fed a concentrate ration that was limited to one-half the protein content. The pigs in each group were started on feed with initial weights of 39 pounds and carried to finished weights of approximately 200 pounds; those in the dry lot required 102 days to attain this weight, those on pasture that received the dry lot ration required 100 days and those on pasture that received a ration limited in protein required 109 days.

## 8. Soft Pork—Swine Research Farm

(In cooperation with Dr. J. O. Halverson)

This year fifty-two pigs were fed peanuts, then finished on a ration of corn and cottonseed meal, while eight pigs were fed a corn and tankage ration until ready for slaughter. Of the 52 pigs that were fed peanuts, thirty were started at average initial weights of approximately 60 pounds, then changed to a corn-cottonseed meal ration at an average weight of 95 to 100 pounds and the remaining 22 pigs had average initial weights of 38 pounds and were changed to the corn-cottonseed meal ration after an average gain of approximately 40 pounds on peanuts.

This work again showed that a "hardening" ration containing 13 percent or more of cottonseed meal had a distinct hardening effect upon the carcasses of pigs that had previously been fed peanuts but when the percent of cottonseed meal in the ration was increased from 13 percent to 20 or 25 percent there was not a proportionate increase in the firmness of the carcasses from the pigs that had been fed the larger amounts of cottonseed meal.

## MEAT PROJECTS

### 1. Quantity of Salt for Curing Meat—Central Station

(In cooperation with Miss Mary E. Thomas)

The method of procedure in this second trial differed from that of the first in that the meat was allowed to stay in cure two and three days per pound per piece instead of three and four days as was done in the first trial last year.

The results show that the amount of salt used in the cure had a slightly greater effect on the actual amount of salt in the meat than did the length of time that the meat was left in cure, but in every case the judges scored less salty hams and shoulders highest, although this was not the case generally with the bacon.

## ANIMAL NUTRITION INVESTIGATION

J. O. HALVERSON, *In Charge*

Investigation is being conducted chiefly in the following projects:

**Soft Pork** (*In cooperation with Mr. Hostetler*). This is a study of the effect of feeding cottonseed meal upon the firmness of carcasses from pigs previously fed peanuts. In the past year, due to an outbreak of the flu during the latter part of the feeding period, only 80.5 percent of the usual

hardness was obtained. Based upon the chemical analysis for the fat constants, 40 pigs out of 52 were hard, 8 medium hard, and 1 medium soft, giving an average ratio of 4.8 of a possible 5 for hard hogs. The physical grading gave an average ratio of 3.9 approaching that of medium hard.

**Vitamin A—In Relation to Feeding Cottonseed Meal and Hulls in Large Amounts to Cattle.** (*In cooperation with Mr. Hostetler.*) In this work both the curative and preventive methods are being used on eight heifers. Two others are being used as controls. The heifers receiving cod liver oil and alfalfa leaf meal incorporated in their rations, have gained in weight similar to the remaining control heifer on a usual ration. The four heifers on the basal ration, or with yellow corn, either lost weight or became blind, or both. Upon the addition of cod liver oil in both rations they improved and began to gain in weight. These heifers are still being fed on these supplemented rations.

This project is an outgrowth of the cottonseed meal feeding studies published in Technical Bulletin No. 39, by J. O. Halverson and F. W. Sherwood.

**Factors Causing Lameness and Death Among Pigs at the Blackland Branch Station, Wenona, on a Ration of White Corn, Fish Meal, and Mineral Mixture.** (*In cooperation with Mr. Hostetler.*) The work this past year with six pigs, consisted of four being fed by the preventive method, two each with yellow corn and alfalfa meal from the beginning. Two pigs were fed on the basal ration alone.

The preventive method of feeding confirmed the curative method using white rats suffering from vitamin A deficiency to which the pig livers were fed.

**The Components of Vitamin B Complex in Cottonseed Meal and in Soybean Meal.** (*In cooperation with F. W. Sherwood.*) This work is in progress. Not enough data have been obtained for a progress report.

The components of vitamin B complex in peanut meal is almost completed. It is being fed to a final series of rats. The study of the effect of ageing of peanut meal is done, as well as the study of the components of raw peanuts. The manuscript of this is ready for publication.

**The Estimation of Free Gossypol Remaining in Cottonseed Meal.** (*In cooperation with F. H. Smith.*) In order to estimate the small amounts of gossypol in meal, a sensitive method is necessary capable of estimating 15 to 30 milligrams of gossypol.

Further work on the method has been done in order to use it in the estimation of gossypol in commercial meals. As the result of considerable work, a paper on the method formulated was given at a Symposium of the Agricultural and Biological Sections at the Eighty-second Meeting of the American Chemical Society, September 4, Buffalo, N. Y.

The method is in manuscript form and is almost ready for publication.

A survey is being made of the amount of gossypol present in the cottonseed meal fed experimentally and in the meals on sale in the State.

**The Effect of the Ration on the Ability of the Albino Rat to Rear Young.** (*In cooperation with F. W. Sherwood.*) The peanut ration without the use of green feed or liquid raw whole milk has been continued with only a few changes, that of adding manganese to one lot (on ration 192 H) and



without it to another lot (also on ration 192 H). This lot later received table scrap or whole milk and raw cabbage for 13 weeks.

The results are tabulated below. They show a fair or moderate number of weaned young. They are in agreement with our previous work. One remaining lot of rats are now being fed on ration 192 H and manganese. All other lots have been discontinued. The 13th generation has been secured on a ration containing peanuts without green feed or raw milk.

Cereal ration 193 E consists of the cereal grains in which 4 percent dried brewer's yeast has been substituted for 4 percent of wheat germ middlings. Ration 193 D contained, in addition to the cereal grains and other essentials, 4 percent of wheat embryo. Both rations contained 10 percent of dried liver.

On ration 193 E, 3 females failed to wean any young out of 90 born while on ration 193 D, 3 females of the  $F_3$  generation weaned 29.6 percent of 27 young. The  $F_4$  generation failed to wean any of the 11 young born.

There appeared to be a general inability of the mothers to produce milk. The cause or causes of this condition may be other than that of the ration which was as adequate in essentials as present knowledge could make them.

## RESULTS ON THE CEREAL RATION 193 D

	M.	Fem.	No. Litters Not Seen	Born Found	No. Litters Weaned	No. Born	Young Weaned	Time on Exp. Wks.	Per Cent Weaned
$F_3$ .....	2	3	2	5	2	27	8	47	29.6
$F_4$ .....	3	2	2	3	0	11	0	38	0.0

## RESULTS ON THE PEANUT RATION MODIFIED

192 F F 7/10*.....	2	3	3	13	2	47	12	46	25.5
F 8/11.....	2	3	2	18	5	105	11	46	10.5
192 G F 1/11.....	2	3	2	13	2	76	10	46	13.2
192 H F 1/11.....	2	2	0	6	1	35	5	76	14.3
F 2/12.....	2	3	2	16	2	96	11	41†	11.5
			0	5	2	17	9	13	52.9
192 H + Mn F/13..	2	3	0	6	3	38	11	20	28.9

\*Total generations on peanuts.

†Raw milk fed daily with cabbage 3 times weekly. (Previously fed table scraps 3 times weekly.)

## MODIFICATION IN PEANUT RATION 192

192 F — 7.5% Dr. Liver; 16 per cent either extracted wheat embryo.
192 G — 8.0% Dr. Liver
192 H — 7.5% Dr. Liver; 7.5 dried brewer's yeast.
192 H + Mn, 0.01 per cent Mn as Manganese Sulphate.

**Completed.** Project on an unknown disease affecting swine when on ration consisting of white corn, fish meal, and mineral mixture. Also a method for the estimation of free gossypol remaining in cottonseed meal. A paper is in manuscript form on the components of Vitamin B Complex in raw peanuts and in its structural parts.

## DAIRY INVESTIGATIONS

C. D. GRINNELLS, *In Charge*

The dairy research work for the year has been largely a continuation of the pasture studies reported on last year. The value of lespedeza as a supplementary pasture and a comparison of lespedeza with alfalfa hay are two new projects which have been added.

### Dairy Cattle Pasture Management Studies II

This is the third year of this study and much improvement in the turf or sod was noted. There are very few eroded areas left and the plant cover is becoming more dense.

The plats used in this study, however, were not as uniform as desired. To correct this handicap all of the low, springy places were tiled. Each plat contains two and one-half acres.

The following table shows the plant food per acre to each plat:

		N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Plat 1.....		100½	75	37½
Plat 2.....		100½	75	.....
Plat 3.....	Check	.....	.....	.....
Plat 4.....	Basic	.....	75	37½
Plat 5.....		79½	75	37½
Plat 6.....		58½	75	37½
Plat 7.....	Check	.....	.....	.....
Plat 8.....		37½	75	37½

This is a cooperative project with P. H. Kime, of the Agronomy Division.

The following table shows the milk yields per plat for the three years:

Plats	1	2	3	4	5	6	7	8
1929.....	7,540	7,261	6,323	6,720	6,708	6,071	5,351	5,580
1930.....	9,419	11,110	6,328	9,218	10,272	8,516	7,076	8,061
1931.....	13,214	14,414	8,446	12,690	11,306	12,200	6,029	11,215

The entire herd was used on this project.

### The Value of Lespedeza as a Supplementary Pasture

In our pasture studies we have found it possible to produce good yields over a long growing season. The rainfall in most years is adequate, except for short periods of severe drought which may come at any time

during the pasture season. These periods make the problem of pasture management very difficult. Adjusting the amount and kinds of supplementary feeds necessary to carry the milking herd and keep up normal production is a problem.

It is the purpose of this work to study the cost and returns from supplementary pastures which are grown to supply grazing during the late summer and fall months when permanent pastures fail, due to drought.

In the spring of 1931 ten acres of previously non-productive land was divided into three three-acre and one one-acre plats. The three-acre plats were seeded to Tennessee 76, Korean, and Common Lespedeza. The one-acre plat was divided into three strips and seeded to the same varieties as the three-acre plats. In both cases the Korean lespedeza was sown in the middle plat.

There was some difficulty in finding land for the project and seeding was delayed until March 28. This late seeding proved to be a severe handicap. Lack of moisture and a hardening of the surface handicapped the small germinating plants in getting started. The late seeding also gave the weeds an advantage in growth.

Each plat has been fenced so that exact yields will be available. Plat 1 (Tennessee 76) has also been tilled so that the entire area is comparable with the other plats.

Dry cattle were grazed for a total of 285 cow-days on the pasture area in September and October. Each plat will be reseeded in February, 1932, and the project will be continued.

This project is in cooperation with Dr. A. J. Pieters, Department of Forage Crops and Diseases, Bureau of Plant Industry, and P. H. Kime, of the Department of Agronomy.

### Dairy Cattle Pastures Management Studies III A

This is a study of intensive fertilization of pasture in the cheese factory section of Ashe County to determine the feasibility of fertilizing pasture lands of known soil type and sod conditions in this area. The topography of this area is such that fields and dairy cattle pastures are necessarily small. The transportation facilities and also the market make it expedient to feed only home grown feeds.

Two typical pasture areas have been used in this study. One is made up of three plats of 2 acres each, and one of three plats of 2.35 acres each. One of these pastures is typical of the bottom areas used for pasture in this section. The other is a hill-side area. Both were partially covered with a fair sod.

One-half of each plat was limed at the rate of 1,000 pounds per acre.

Plats 1 and 3 in both pastures were fertilized with 750 pounds of an 8-4-4 mixture per acre. In addition, plats 3 of both pastures were top-dressed with 100 pounds of nitrate of soda per acre.

The fertilized plats produced approximately 1,100 pounds more milk per acre than the check plats. The increased yield was not large enough to pay for fertilization with prevailing milk prices.

In cooperation with P. H. Kime, Agronomy Department, and the National Fertilizer Association.

### **Dairy as a Supplementary Enterprise**

This is a study of dairying as a supplementary enterprise to cotton farming.

The crop just harvested completes the first cycle of the rotation, so no comparisons can be made as to the value of the rotation in increasing crop yields.

The dairy herd showed a profit of \$236.59 for the year of 1930. This profit was based on sales of products at current prices and deducting all expenses that could possibly be charged to this phase of the project.

This is a cooperative project with the Farm Management and Agronomy Departments.

### **A Study of the Comparative Value of Alfalfa and Lespedeza Hay for Dairy Cattle**

This study was started during the winter of 1930-31 at the Central Experiment Station. Eight cows were used with the double reversal method consisting of thirty day periods.

This project is being continued this winter with three feeding trials in progress at the Central, Coastal Plains, and Mountain Experiment Station dairies in cooperation with Dr. A. J. Pieters, Department of Forage Crops and Diseases, Bureau of Plant Industry, Assistant Directors Charles Dearing, S. C. Clapp; dairymen Tom Cameron, Harry Coulter and G. S. Carter.

### **Bovine Infectious Abortion\***

This is a study of a plan to control and eradicate Bovine Infectious Abortion by segregation plus good sanitation. All herds with one exception, have adopted a very complete form of segregation.

The data obtained this year on a few herds which adopted the plan of segregating all reactors within a short distance from the negative herd—indicates that with ordinary labor the more complete the segregation of reactors, the better the results.

### **Relation of the Conformation and Anatomy of the Dairy Cow to Her Milk and Butterfat Producing Capacity**

This study involves ante-mortem and post-mortem measurements on cows with records of production. Data have been secured on two Jerseys, one Guernsey, and two Ayershires. Plans have been completed to include a larger number of animals in this study for the coming year.

This project is in cooperation with the Bureau of Dairy Industry and seventeen other State experiment stations in cooperation with Prof. F. M. Haig.

### **Dairy Cattle Pasture Management Studies III**

*Mountain Branch Station, Swannanoa, N. C.*

This is a continuation of the study of intensive pasture management under Western North Carolina conditions.

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\*In cooperation with Dr. William Moore and Dr. L. J. Faulhaber, Veterinary Division of the North Carolina Department of Agriculture.



This year's milk and butterfat yields are not as large as those of 1930. This is no doubt partly due to the drouth of 1930 and its effect on the reserve of plant food to carry through the winter. The turf did not equal that of 1930 in density. Volunteer annual grasses made a good growth but they did not compensate for the decreased density of the permanent sod.

The following table shows the plant food per acre for each plat:

		N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Plat 1.....	Check Basic	24	48	24
Plat 2.....		24	48	24
Plat 3.....		....	....	....
Plat 4.....		....	48	24
Plat 5.....		24	48	24
		15	....	....
		15	....	....

#### MILK YIELDS FOR 1930 AND 1931

Plat No.	1	2	3-Check	4	5
			No fertilizer		
1930.....	14,426	16,422	9,998	8,508	13,986
1931.....	12,570	13,106	8,708	7,928	11,592

The whole milking herd was used on this project.

This is a cooperative project with P. H. Kime, of the Agronomy Division, Assistant Director S. C. Clapp, and Dairyman H. B. Coulter, Mountain Branch Station.

#### Dairy Refrigeration Studies

##### *Coastal Plain Branch Station*

This project is a study of dry storage to determine its efficiency on the average dairy farm. This type of machine is not recommended largely for retail dairies, but it meets the requirements of the Station dairy with its retail and wholesale trade.

These data will be supplemented by data on a wet storage machine at the Central Station dairy.

The following is a summary of the data for 1930:

	Gallons of Milk Cooled	Temp. of Milk from Cooler Chamber	KWH Used	Cost at 4c per KWH
Monthly average.....	612	37.25 degrees F.	187	7.43

### The Value of Fly Repellants in Maintaining Summer Milk Production

This is the second trial which has been completed with a commercial fly spray. The spray appeared to be more effective for an hour after application. After this time there appeared to be little difference in the number of flies on the two groups—the sprayed and unsprayed.

The results from the first trial show 2.2 percent more milk for the sprayed than for the unsprayed group.

This small difference may be within the limits of experimental error. This is a cooperative project with Assistant Director Charles Dearing and Dairyman Tom Cameron.

### Community Sire Study

#### *Blackland Branch Station\**

Wenona Chief of Bachelor's Retreat 126468 (a pure-bred Guernsey bull) has completed four years service at the Blackland Station as a community sire. During this period he was mated as follows:

1927	-----	17
1928	-----	36
1929	-----	22
1930	-----	22
1931 to June 1st	-----	10

The slight decrease in number of services in 1931 is due to the fact that the cow population of the community is made up largely of Chief's daughters. These will be mated with Relay Wenona Chief of B. R. 180445, a promising production-bred yearling which has been selected to continue the project.

Twenty of Chief's daughters made a very attractive exhibit at the seventh annual farmers' field day. They were a very promising looking group with uniformly deep bodies and an excellent udder development.

That the grade Guernsey heifers are appreciated is indicated by the prices paid for the few that have been sold. Approximately forty-five heifers have been sired by "Chief." These heifers are being matured at a low cost due to the fact that they can be pastured on reeds from May 15 to the latter part of October without supplements and make a good growth.

R. H. RUFFNER,

*Head, Department of Animal Industry.*

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\*In cooperation with Assistant Director J. L. Rea, Blackland Station.

# RESEARCH IN BOTANY

## Division of Plant Pathology

S. G. LEHMAN, *In Charge*

### COTTONSEED TREATMENT

The cottonseed treatment tests begun a few years ago were continued, using a wide variety of chemical dusting materials. In general, the temperature and moisture conditions which prevailed at seeding time were favorable to obtaining a good stand, even where seed were not treated. Because of this condition, no benefit resulted from the use of treated seed in some of the tests. However, notwithstanding the favorable conditions for seed germination, results favorable to dusting seed previous to planting were obtained on many of the farms where tests were made. Table I gives the results of a test conducted at the Upper Coastal Plain Branch Station, in cooperation with Mr. P. H. Kime, of the Agronomy Department. On this farm, dusted and undusted seed sowed at different rates were compared in respect to stand of plants and yield of seed cotton. The seed were put in with a hill drop planter, and the rates of seeding were secured by adjusting the planter to drop the seed at distances of 12, 18 and 24 inches. When the plants were up, certain rows were thinned to a uniform number of plants per hill, and other rows were left unthinned. In this test, treated seed planted at the rates of 24.8 pounds and 37.2

TABLE I

STAND OF PLANTS AND YIELD OF SEED COTTON ON PLOTS PLANTED TO DUSTED AND UNDUSTED SEED AT DIFFERENT RATES PER ACRE AND ON DIFFERENT DATES

Seed Treatment and Plant Thinning	Rate of Seeding in Lbs. per Acre	No. of Plants per 90-Foot Row*		Total Yield of Seed Cotton—Lbs. per 90-Foot Row	
		Seed Planted April 13 †	Seed Planted April 28 †	Seed Planted April 13 †	Seed Planted April 28, †
Not dusted, thinned	37.2	159	164	10.32	10.68
Not dusted, not thinned	37.2	268	458	10.90	11.24
Dusted, thinned	37.2	163	193	11.08	11.46
Dusted, not thinned	37.2	373	504	11.80	11.86
Dusted, thinned	24.8	136	125	10.26	11.20
Dusted, not thinned	24.8	318	418	10.86	11.68
Not dusted, not thinned	24.8	220	373	9.28	11.38
Dusted, not thinned	18.6	202	281	9.98	11.48

\*Count made October 2.

†Each number given below is average of 5 applications. Each yield increment of 0.1 lb. per row is equivalent to 13.8 lbs. per acre.

pounds per acre gave better stands of plants and yielded more seed cotton per acre than untreated seed. When rows planted to treated and untreated seed at the same rate per acre were thinned to approximately the same stand, the treated seed gave the higher yield. Treater seed planted at the rate of 24.8 pounds per acre and not thinned yielded as much seed cotton in the April 13 planting, and more in the April 28 planting than untreated seed planted at the rate of 37.2 pounds per acre. Likewise, treated seed planted at the rate of 24.8 pounds per acre and thinned, yielded practically as much seed cotton in the first planting, and more in the second planting than untreated seed planted at the rate of 37.2 pounds and thinned. Dusting enabled seed planted at the rate of 18.6 pounds per acre to surpass or equal the yield of untreated seed planted at the rate of 24.8 pounds per acre. Dusted seed usually produce a larger number of seedlings from which to make selection at thinning time (Figure 3), hence a more uniform stand may be obtained. Where saving of seed is a matter for consideration, dusting will usually enable one to plant 20 percent to 50 percent less seed and still obtain as good a stand as if a larger amount of untreated seed were planted.

### BARLEY SEED TREATMENTS

The loose and covered smuts of barley have caused large losses in this State in the past few years. The covered smut can be effectively controlled by use of dust treatments. However, the greater portion of the losses from smuts in barley in this State are due to loose smut. The control hitherto recommended for this disease has been the hot water treatment. Recently it has been shown that loose smut can be controlled in some varieties of barley by treating the seed with formaldehyde and certain organic mercury compounds. Unfortunately these simple treatments are not effective against loose smut on all varieties of barley.

Tennessee hooded barley is grown extensively in this State, but apparently this variety has been used in none of the tests for loose smut control for which results have been published thus far. In order to determine if loose smut in this variety can be controlled by simple dust treatments, or if the more cumbersome hot water treatment must be used, a preliminary test was made in the season just past. Separate lots of seed were treated with ethyl mercury chloride, with two different commercial brands of dust containing formaldehyde, and with hot water. In some of the treatments the seed was kept in contact with the formaldehyde dust in air tight containers for periods up to 24 hours. For the hot water treatment, the seed was pre-soaked 5 hours in cool water, dipped momentarily in water at 119° F., held for 13 minutes in water at 125° F., then immediately cooled and dried.

Neither ethyl mercury chloride nor the formaldehyde dusts gave any significant reduction in loose smut. The hot water treatment gave complete control of this disease. The most prolonged dust treatment, 24 hours with formaldehyde dust, had no appreciable effect on the stand of grain as indicated by a comparison of head counts made on treated and untreated rows. As indicated by the same criterion, a reduction of 36.3 % in stand followed the hot water treatment. This result would indicate that when the hot water treatment is applied to Tennessee hooded barley



a temperature lower than 125.6° F. or a period of heating shorter than 13 minutes should be used to avoid seed injury. Further tests are being made to determine if lower temperatures or shorter periods of treatment will not give satisfactory control of loose smut in this variety of barley.

### OAT SMUT

A limited number of materials were tested again this year for control of loose smut of oats. Formaldehyde applied as a liquid (spray method, using 1 part 40 percent formaldehyde to 1 part water) gave complete control of smut. Smuttox, a commercial dust preparation containing formaldehyde as the active ingredient, gave fair control when the seed was stored in a closed paper bag for 5 hours after treatment. Somewhat better control was obtained with this dust when the treated seed was stored in a tight receptacle for 5 hours, and less than one-half percent of smut developed in plants grown from treated seed which had been stored in the tight receptacle for 48 hours following treatment. Another commercial dust preparation containing both formaldehyde and ethylmercury chloride gave poor control when treated seed was stored for 5 hours in a tight container. Longer periods of storage were not tried with this preparation. Ceresan, a commercial dust preparation containing ethylmercury chloride as the active ingredient, reduced smut to less than 1 percent. The 42 untreated check rows in this test produced an average of 17.6% of smutted heads.

Stand counts made 25 days after the October 29 planting showed 10.7 percent reduction in stand on the rows planted to seed which had been sprayed with formaldehyde. This reduction was fully compensated by increased stooling as is indicated by the fact that these same rows at harvest time had 1.4 percent more heads than the corresponding check rows.

That weather conditions immediately following planting profoundly influence the percent of smut which may appear in plants grown from smut infested seed was well illustrated by results in the smut tests of the past year. The results given in the paragraph described above were obtained from seed planted October 29. Another planting of the same test using seed from the same lots was made on November 24. An average of 17.6 percent of the heads of plants from untreated seed were smutted in the planting made October 29, while less than 0.2 percent of the heads were smutted in the planting on November 24. Planting on October 29 was immediately followed by rain which thoroughly wet the soil and kept it wet for a week or more. On November 24, when the second planting was made, the soil contained abundant moisture for seed germination, estimated as 40-50 percent of its water holding capacity, but no measurable amounts of rain fell for 7 days after planting, as indicated by weather bureau records taken on the Station farm where the test was being conducted. Thus it happened that germination of the seeds planted on the two dates took place in soil having a difference in water content. Of greater probable significance, however, was a marked difference in temperature following the two dates of planting. The early planting was followed by moderate day and night temperatures, while the late planting was followed immediately by cold weather, temperatures below freezing occurring on several nights. The mean maximum and the mean minimum

temperatures during the 10 days immediately following each date of planting were 55.9 degrees and 38.4 degrees Fahrenheit for the early planting, and 48.4 degrees and 29.3 degrees Fahrenheit for the late planting. Thus it is seen that the mean maximum and the mean minimum temperatures were respectively 7.5 and 8.1 Fahrenheit degrees lower for the 10-day period immediately following the late planting than for the corresponding period following the early planting.

### WHEAT ROSETTE AND MOSAIC

Certain wheat lands of the State have been found to be infested with the virus of the wheat mosaic disease. One phase of this disease has been given the name rosette because of the extreme stunting (Figures 2 and 3) which is produced in certain varieties. Relatively few varieties exhibit the rosette symptoms of the disease, but in these varieties losses are severe. Many varieties exhibit only the mosaic or leaf mottle phase of the disease. Of these varieties the disease is usually accompanied by more or less marked reduction in yield, but the symptoms are such that the disease may easily pass unnoticed, the grower remaining ignorant of the true cause of the low yields.

As a cooperative undertaking between this Station and the Bureau of Plant Industry, United States Department of Agriculture, a number of varieties and selections of wheat were planted on the farm of Mr. J. R. Young, Lexington, N. C., in order to determine if any show promising resistance to this disease and are at the same time well adapted to that locality. In this test Tuscan Island and Harvest Queen became severely diseased and made average (estimated) yields of less than 5 bushels per acre. Nittany, a Fulcaster wheat, showed strong manifestations of certain phases of the disease and produced an average yield of less than 10 bushels per acre. Certain other varieties, selections and hybrids, tested on the same land showed little or no evidence of the disease and produced yields (estimated) of 25 or more bushels per acre. The most promising of these varieties are being tested again with a view to increasing the one which may be best adapted to our climatic conditions.

### WATERMELON WILT

Many fields in North Carolina are infested with the watermelon wilt diseases. It is not a safe practice to grow watermelons on the same land in two consecutive years since large losses from wilt frequently occur. The land must be temporarily abandoned for watermelon culture. Even when the crop is put on new land, now becoming less and less available, it happens not infrequently that wilt occurs in the crop. A watermelon showing high resistance to wilt and at the same time having suitable size, flavor and shipping qualities, would be a great boon to the grower whose land is infested with wilt.

The Iowa Agricultural Experiment Station recently developed three new varieties of watermelons which show marked resistance to wilt in the areas where they originated. In order to determine the performance of these wilt resistant varieties when planted on North Carolina soils which are infested, tests of two of the varieties were made in the summer of 1931. Plantings were made at three locations, namely, Goldsboro,

Calypso, and Faison, on land on which a high percentage of a commercial crop of melons wilted in the summer of 1930. In each test a non-resistant variety was used as a check to measure the degree of soil infestation. An equal number of hills, 50 or more, were planted to each variety, and a record was kept of the number of hills which became diseased.

The results show that while the two resistant varieties, Pride of Muscatine and Iowa King, which were used in these tests, are not immune to the form of the wilt fungus occurring in North Carolina soils, they are much more resistant than varieties such as Keckley Sweet and Stone Mountain which are being grown commercially.

The melons of the two resistant varieties used in these tests are somewhat below the size and weight desired by growers who are producing melons for shipment to distant markets. On the other hand, they are probably more suitable than the larger melons for sale on local markets, and they possess the desired biologic property of resistance to disease which makes possible greater production on wilt-infested land.

### TOBACCO MOSAIC

A small, grey-black, winged insect (*Dicyphus minimus*), commonly called the tobacco suck fly, occurs in large numbers on tobacco plants in the field in late summer and early fall. In two tests a number of these flies which had developed from the egg to the adult stage on tobacco plants infected with common tobacco mosaic, were colonized on young American tobacco plants. The insects fed amply, and reproduced on the leaves of these plants, but none of the plants developed mosaic. Apparently the tobacco suck fly is not a vector of the virus of common tobacco mosaic.

A number of tests were run to determine how readily the virus of common tobacco mosaic enter plants through their roots. Plants were allowed to grow in soil to which juice pressed from diseased leaves had been added in such quantity as to give a much higher virus concentration than one would expect to find in the soil in nature. When the plants were set in such a position that only the lower-most portion of the stem, the crown, came in contact with infested soil, 2 plants out of 38 became diseased. This is a much lower ratio of disease to healthy plants than one should expect if the virus enters readily through roots. When the plants were set in such a position that only their roots and no portion of the stem or leaf came in contact with the infested soil, no mosaic symptoms appeared on the plants, even though they were allowed to grow in the infested soil till blooming time. Tests made on the soil at the time the healthy plants were removed showed the virus in the soil to be still viable and capable of causing mosaic when rubbed on leaves of tobacco plants.

In other tests the mosaic virus in water suspension was brought into contact with injured and uninjured roots. When uninjured roots were immersed for 48 hours in the virus (1 part tobacco juice in 12 parts water) then removed to water for the remaining 64 days of the test period, none of the plants became diseased. No infection occurred when very small rootlets were severed and placed in contact with virus suspension. When larger rootlets having a diameter of 1 to 2 mm. were severed and placed in contact with virus, mosaic developed on somewhat more than half the plants.



The tests designed to study the relation of the time and manner of disposal of the stalks and roots of a previous diseased crop on occurrence of mosaic in the succeeding tobacco crop were continued. The results of these tests indicate that the percentage of disease which originates directly from soil infestation induced by growth of a previous diseased crop is relatively low and is somewhat dependent on the method of treatment of diseased stalks and roots. A lower percentage of plants became diseased where the stalks and roots were cut up by thorough disking in the fall than where they stood over winter and were plowed under in the spring. More mosaic occurred where the diseased stalks and roots were plowed under in the fall without previous disking than where they stood over winter and were plowed under in the spring. Four to five times as much disease occurred where four times as many disease stalks and roots as normally grow on the land were plowed under in the fall as where only the normal number of diseased stalks and roots were plowed under, but increase of disease from this treatment did not occur where the stalks and roots stood over winter and were plowed under in the spring. When diseased stalks and roots are covered with soil by plowing under in the fall without such mutilation as results from disking, many of them are preserved in a living condition by the soil covering and send up diseased sprouts about time for setting tobacco in the spring. After the stalks have stood over winter in the open they are so depleted in vitality as to be unable to form suckers the following spring. The presence of living diseased sucker growth in the soil at transplanting time probably accounts for the occurrence of more mosaic when the stalks were plowed under in the fall without previous disking. In these tests no disease occurred on check plots where mosaic-free tobacco grew in the previous season.

A test was made to determine how extensively mosaic may be spread in the topping operation. One plant out of every 10 was inoculated artificially. At topping time the mosaic disease was present on approximately 10 percent of the plants, and these were standing in uniform distribution throughout the test plots. In topping one plot no plants visibly diseased were touched until after all healthy plants had been topped. On the other plot healthy and diseased plants were topped, i.e., just as they came in the row. A count made 18 days after topping showed that mosaic had increased from 10.6 percent (inoculated plants) to 16.9 percent where the healthy plants were topped first, and from 10.5 percent (inoculated plants) to 40.7 percent on the plot where healthy and diseased plants were topped indiscriminately. The increase from 10.6 percent to 16.9 percent where the healthy plants were topped first was probably due to spread of mosaic in cultivation.

A test was made to determine the spread of mosaic in cultivation as distinguished from topping. Plants were artificially inoculated at uniform distances in certain rows. In topping no diseased plants were handled until after all healthy plants had been topped. Between July 6, the date on which the artificial inoculations were made, and August 17 mosaic increased from 5.4 percent (inoculated plants) to 14.9 percent on the plot where every 20th plant had been artificially inoculated, and from 10.5 percent (inoculated plants) to 40.5 percent on the plot where every 10th plant had been artificially inoculated. The disease had also spread



laterally into several rows which had not been artificially inoculated. After the count on August 17, the disease increased very rapidly in all plots. By September 9, 79.8 percent of the plants showed mosaic symptoms where 1 out of 20 had been artificially inoculated and 95.4 percent were diseased where 1 out of 10 had been inoculated. An adjoining plot of 5 rows in which no plants had been inoculated had 74.8 percent of diseased plants. Spread of the mosaic virus on the implements of cultivation becomes surprisingly great and very extensive after the plants have become large enough to rub the implements as they pass in cultivation. On certain plots where infection was coming from contaminated soil the disease was held in check effectively by roguing out the diseased plants just previous to each cultivation.

### A NEW TOBACCO ROOT DISEASE

During the past summer a number of tobacco fields were observed in Wake, Johnston, Nash, and Edgecombe counties in which many of the plants were making poor, irregular growth. The plants were stunted to varying degrees, and showed a marked tendency to wilt during the hot part of the day (Figure 6). Recovery of the turgid condition occurred at night, only to be followed by recurrence of wilting the next day. The plants had a light yellowish cast in contrast to the normal green of healthy plants. Many of the leaves, particularly those at the middle and lower part of the plant, showed yellow margins which were becoming necrotic. Definite brown lesions were present on the larger roots and many of the small rootlets were brown and dead over a considerable portion of their length (Figure 7). The greater apparent root injury was



Figure 6.—Portion of a tobacco field in which fully 90 percent of the plants were infected with the new brown root-rot disease. Note the irregular size of the plants, and the limp developing habit of the leaves.

on the smallest rootlets, those which produce the root hairs and function most intimately in the absorption of water and plant nutrients. Roots deep in the soil showed more injury than those near the surface.

By certain observers the disease was mistaken for black root rot (*Thielaviopsis basicola*). However, the color of the diseased areas was unlike that of black root rot, being distinctly brown, not black. Careful microscopic examination of the diseased tissues revealed neither spores nor sporophores resembling those of the black root rot fungus. Indeed mycelium was not at all abundant and fungus spores of any kind were rarely found in or on the diseased tissue.

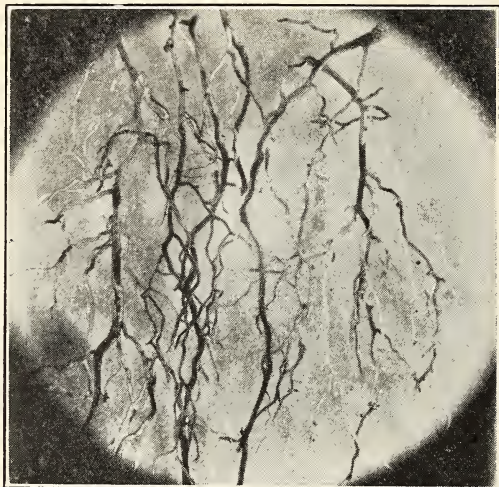


Figure 7.—Lesions on the roots of tobacco plants infected with the new brown root-rot disease. Roots magnified to twice their natural size. Note that portions of the rootlets are brown and obviously diseased.

This disease is very decidedly a brown root rot, but it apparently is not of the same origin as the brown root rot occurring in northern tobacco growing areas. The brown root rot of northern areas is most severe on the first tobacco crop and becomes less and less severe with continuous culture of tobacco on the same soil. In the fields in which this new brown root rot was observed, tobacco has been in continuous culture for several years and the disease, as reported by the growers who had observed the condition in previous years, is becoming increasingly severe.

Isolations made from diseased roots yielded a species of *Fusarium*, a species of *Aspergillus*, a phycomycetous fungus not yet identified, and bacteria. However, the disease has not yet been produced by artificial inoculations with these organisms. In examining the macerated tissues of diseased rootlets, nematodes which appeared to be different from the common root knot nematode were observed to be present in considerable numbers. Diseased roots were submitted to Dr. G. Steiner, Division of Nematology, United States Department of Agriculture, who identified the nematodes present in them as *Tylenchus pratensis*. This nematode is reported as being widely distributed in temperate and tropical regions and occurs as a parasite in the roots of wheat, rye, barley, corn, cotton, sugar



cane, tomato, strawberry, Irish potatoes, fig, violets, sugar beet, rape, and other plants. The disease symptoms on these plants are much like those described above for tobacco. While its cause has not yet been established by experimental evidence, the presence of *Tylenchus pratensis* in the diseased roots may be considered as strong indication of the causal relation of this nematode to this new tobacco disease.



Figure 8.—Tobacco plants grown in the greenhouse in soil taken from a field infested with the new brown root-rot disease. Soil in end pots steam sterilized before setting plants in it; the three middle pots not sterilized.

The occurrence of this new brown root-rot disease appears to be in some way influenced by use of lime. All the fields in which the disease has been found to date have been limed and have a reaction which is alkaline or only slightly acid. For example, the disease was severe and general in a field having a soil reaction of pH. 6.4, while only a trace of disease was found in an adjacent field having a soil reaction of pH. 5.5. Not all fields which have been limed to the point of neutrality or near neutrality show the disease. In some such fields only an occasional plant shows obvious signs of infection, while in other fields of similar soil reaction no diseased plants were found. Without the presence of the causal agent, whatever that may be, the disease does not occur.

The disease has been produced in the greenhouse by growing plants in unsterilized soil taken from diseased fields. Plants growing in the same soil which had been sterilized did not become diseased. Figure 8 shows plants grown in the greenhouse in sterilized (end pots) and unsterilized (middle pots) soil taken from beneath diseased plants growing in an

infested field. Figure 9 is a photograph of the roots of these plants. It does not seem advisable to continue planting tobacco on infested soils. Losses of more than 50 percent of the crop were sustained in two of the fields observed.



Figure 9.—The roots of four of the plants shown in Figure 8.

## PLANT DISEASE STUDIES

R. F. POOLE, *In Charge*

### A Study of the Control of the Bacterial Spot of Peaches and the Nearly Similar Canker and Spot Caused by Arsenate Injury and Their Control

The bacteriosis, or bacterial spot disease was first observed this season on the fruit on May 1. It occurred on foliage June 5. It was not severe on foliage at any time during the growing season and up to September. The greatest amount of infection occurred when wet weather developed in July just previous to harvest. There was heavy fruit infection in several orchards near Hamlet and Marston, but many orchards of Elberta and Hale varieties in this same area showed very little infection.

The amount of infection on varieties and even on the same variety was very variable. The Hale variety known to be most susceptible of all varieties grown in the sandhills, had 100 percent infected fruit on trees which ripened fruit July 25, in comparison to 10 and 20 percent infection on trees of the same varieties where the fruit did not ripen until August 5. The fruit on the former were also more severely spotted. The trees



which ripened the fruit first showed lack of healthy condition, due to infections of *Armillaria mellea* and *Bacterium tumefaciens* which had injured the root system badly, and weakened the trees so much that heavy pruning and cutting back of old limbs during 1930 was considered necessary for maintaining bearing wood. This low vitality does not seem to account for the difference in infection altogether, since there was greater infection on trees not attacked by these same organisms in other orchards than on trees badly diseased by these two causal organisms of root rots in the same orchard. Studies on infection periods do not clearly account from this phenomenon, but seem to indicate that heavier infection may in some way be more directly related to the advancement toward maturity of the parts at the time that conditions are most favorable for infection. The Georgia Bell variety growing adjacent to Elberta, which was well infected, showed very few fruits with bacterial spots and no leaf infection.

Trees fertilized in either autumn and spring seasons with nitrate of soda up to five pounds to the tree had up to 100 percent fruit infection. The general vigor of the trees in this test indicated only very slightly greater growth than those which had not received additional nitrates.

Spraying and dusting experiments were conducted on three farms, Z. V. Pate's, Laurel Hill; R. B. Donaldson's, West End; and R. W. King's, Raleigh. Satisfactory bacterial infection on peaches of 47.7, 55.8, and 16.3 percent occurred on untreated trees in the three orchards, respectively. Five applications of each chemical at the rate of five gallons to the tree, was applied, beginning April 23, soon after shuck fall, which was delayed about ten days as compared with the shuck fall of 1930. Ten relatively uniform trees were used in each test for each treatment. The sprays were applied with power machines with pumps that developed above 200 pounds pressure. The results were obtained July 24 and 25, when the first peaches had ripened. The examination of each peach was readily made on the trees, since in this area the trees are pruned heavily and most bearing wood is less than eight feet above the ground.

The results of the test on the Pate farm will be given, since the data is quite representative of results obtained on other farms.

The results are given for peaches slightly infected, or peaches with few recently developed spots, and for peaches badly infected, or peaches with numerous spots, scab-like spots, and otherwise injured sufficiently to greatly lower the market value. In this orchard the trees that were not treated with any spray had 32.8 percent slightly infected, 14.9 percent badly infected peaches, making a total of 47.7 percent diseased peaches. Every treatment, including the zinc dust which gave the least control of any substance used, reduced the amount of slight infection, but not impressively. The same treatments reduced the amount of severe infection remarkably, especially the zinc-lime sprays. The 4-4-50 and 8-8-50 strengths kept the amount of severe infection at 4.9 and 1.6 percent respectively, and finishing lime held the infection to 4.8 percent as compared with 14.9 percent on trees that were not sprayed. The lowest total infection occurred on trees treated with lime. Whether or not the suspected hydroxyl-ion is responsible for the reduction was not determined. None of the chemicals used in these tests caused any form of injury, or in any way injured the market quality. All other treatments with other chemicals reduced severe infection from 2.5 to 9.3 percent.

The first tree of each treatment was exposed to sand storms, and all showed heavy fruit infection regardless of the treatment, indicating that injury of fruit and foliage is directly favorable to infection, which may develop even when the parts are well coated with spray materials.

The close similarity of leaf spotting, cankering of twigs and limbs and fruit injury by arsenate of lead, and by the *Bacterium pruni* is often confusing, even to an expert. Injury from both is often severe in the same orchard, because wet seasons are very favorable to both. Leaf spotting caused by arsenate is of a more circular form, in comparison with the more angular bacterial spot. Physiological spots also bear some resemblance to general characters of these spots. On the twig the arsenate spot is found most abundantly in the cracks, and at the base of the bud as compared with the irregular and less numerous bacterial cankers occurring on any part of the twig. On the fruit the arsenate injury causes a sunken irregular but sometimes circular spot with yellowish to purplish borders. These spots are larger than those caused by the bacterial organism and the depth to which the tissues are injured is also greater. Fruit on the sun-exposed areas, and the parts nearest to the stem are most severely injured. Gums exude from the injured parts, but this may result from any form of peach injury. The shot hole symptom also develops from foliage injury of any type if the parenchyma cells are killed, since the uninjured tissues callouse well and the diseased parts shrink away from the healthy parts and are easily blown out.

When arsenate of lead is used, recommendations call for the use of five pounds of lime with one pound of high-grade powdered arsenate of lead in 50 gallons of spray material. The growers have generally used some form of hydrated lime, which does not always counteract the effects of the arsenate, especially if the season is a wet one and if three or more gallons of material are applied to a tree. During the course of studies on bacterial control it was shown that zinc sulfate is an excellent buffer for the toxicity of arsenate of lead and greatly lowers arsenate burn even when five gallons of spray is applied to a tree. The results indicate that eight pounds of zinc sulfate was slightly more effective in preventing arsenate burn of fruit than four pounds. In one test there was 5.5 percent burn on plots where four pounds of zinc sulfate was used with one pound of arsenate of lead as compared with 2.2 percent where eight pounds of zinc sulfate was used. The burn amounted to 17.5 percent when five pounds of hydrated lime was used with one pound of arsenate and 7.9 percent when 20 pounds of hydrated lime was used. Where five pounds of finishing lime, a finely screened white hydrated lime, was used the burn amounted to 4.6 percent. The general appearance of the chemical deposit on the foliage indicated that the more finely screened lime had remained on the foliage more satisfactorily than had the coarse hydrated lime. It is clearly shown in these results that both gypsum and land plaster were ineffective buffer materials, since injury amounted to 11.6 and 57.3 percent, respectively, when five pounds of these materials were applied with one pound of arsenate of lead in 50 gallons of water.

The brown rot disease caused by *Sclerotinia fructicola* was severe on peaches of the Hale and other varieties ripening August 5 to 10. Constant rains during the latter part of July and first part of August made conditions very favorable for brown rot. Colloidal sulphur was very

effective in controlling the disease. Zinc sulphate plus lime also prevented serious infection. Other materials including lime and potassium permanganate, delayed infection. But substances including sulphur and zinc sulphate did not offer definite protection after the fruit had ripened, even though perfect control was maintained up to the ripening period. The untreated trees showed heavy infection of fruit before peaches began to ripen, with total loss occurring on many trees.

The excellent sticking qualities of colloidal sulphur and its reduction of the bacterial spot suggest tests with greater amounts of this chemical alone and in combination with other chemicals. Amounts up to 15 pounds of this chemical in 50 gallons of water did not injure foliage or fruit. These results further show the possibilities of zinc sulphate as a spray for the control of important diseases of the peach.

AVERAGE RESULTS OF SPRAYING AND DUSTING PEACHES ON Z. V. PATE'S FARM  
FOR THE CONTROL OF THE PEACH BACTERIAL SPOT

Treatment	Strength	Bacterial Infection Slight Percent	Bacterial Infection Severe Percent	Total Infection Percent
Check.....	.....	32.8	14.9	47.7
Zinc Dust*.....	1 lb. to tree	25.8	12.4	38.2
Zinc Lime.....	4-4-50	23.3	4.9	28.2
Zinc Lime.....	8-8-50	24.3	1.6	25.9
Zinc-Sulfur-Lead Arsenate †.....	10-50	19.4	6.7	26.1
Lime (finishing).....	25 to 50	12.2	4.8	17.0
Colloidal Sulphur.....	5 to 50	16.4	5.6	22.0
Potassium Permanganate.....	1-500	23.1	6.5	29.6
Emulsified Cresol.....	1-200	17.6	5.8	23.4
Emulsified Cresol plus Sulphur (6).....	‡1-200 5 to 50	26.2	7.7	33.9
Emulsified Phenol.....	1-200	17.4	7.3	24.7
Colloidal Calomel.....	4-50	18.7	6.5	25.2
Gypsum.....	§ 25- to 50	22.4	9.1	31.5
Gypsum Land Plaster.....	25 5 50	13.3	11.2	24.5

\*Equivalent to 4 pounds of zinc sulphate in 50 gallons water and 5 gallons to each tree when applied at the rate of one pound to the tree.

†Basic material with 4 pounds zinc sulphate.

‡Liquids measured on the basis of cubic centimeters.

§Solids in pounds.

### A Study of the Cane Blight Disease of Dewberries and the Control of the Causal Organism

The study of the *Leptosphaeria coniothyrium* cane blight was continued in cooperation with Williams, of Horticultural Department, on the farm of Z. V. Pate, Laurel Hill. The results obtained in these studies concern the effect of different forms of pruning on the control of the fungus, and prevention of prematurely ripened berries.

The period from July to November when bearing canes were developed was not satisfactory for best growth because of dry weather. Where plants were pruned as late as July 15, the cane growth was short, sometimes not exceeding two feet in length. This was especially noted on plants of ages from eight to fifteen years. The more recent plantings of two to four years showed more consistent uniformity of cane growth. The early part of the



1931 season was very favorable for the formation of berries, but also favorable for the greatest development of anthracnose on berries, canes, and leaves since 1925. In many fields this disease caused a loss of 50 to 75 percent of the crop. The character of cane infections, being somewhat similar to that caused by *Leptosphaeria coniothyrium* made it difficult to secure results on the latter near the harvest period in June. Blighting of canes, resulting in prematurely ripened and immatured berries, (Figure 6) occurs when either disease kills the canes. The anthracnose is most severe on the fruit spurs, but the *Leptosphaeria coniothyrium* fungus blights by girdling the canes near the ground and by working downward below the canes on old spores.

Plants pruned just beneath the soil in 1929 and again in 1930 had .4 percent dead canes as compared with 10.9 percent on plants cut by hoes in which some were properly cut beneath the soil, and others above, in which long spurs were left exposed. Plants pruned just beneath the soil in 1930 had 1.4 percent dead canes. When pruned high leaving long stubs, the dead canes amounted to 43.8 percent. Plants pruned beneath the soil from the beginning of the planting were maintaining greater uniformity of cane growth and freedom from any form of cane blighting. It is definitely shown from these results that careful pruning of old canes beneath the soil from the beginning is important and will result in more satisfactory cane growth than will severe pruning after the plants are more than eight years of age. These results also show that pruning immediately after harvest is important if the canes are to be cut low, and, that cutting below the stump head will seriously delay the formation of new canes of sufficient length for best yields.

#### A Chemical Control Study of Wilt Diseases Caused by *Fusarium lycopersici* and *Bacterium solanacearum* and Other Organisms Causing Root Rot

When sulphur was applied to Durham sandy soil under the tobacco hill as during the 1930 season, the reaction of the soil changed very slowly from pH. 5.0 and an acidity of pH. 4.0 was not obtained until after heavy infection had occurred in June, the infection on the treated soils being 90 percent, as compared with 100 percent on untreated areas. Sulphur was applied broadcast and in the row at the rate of 200, 300 and 600 pounds to the acre one month before planting, but the drought conditions which prevailed for a month prevented a satisfactory change in reaction before heavy infection had occurred. Acid phosphate, of commercial super grade, gypsum, and hydrated lime at the rate of 1,000 pounds to the acre, were also used. None of these materials checked the bacterial disease. It is shown from soil samples collected in fields where the bacterial disease is severe that the bacterium will tolerate an acidity of pH. 4.8 under field conditions, and the reaction of the soil where the disease is most severe is pH. 5.0. This very high acidity tolerance seems unusual for bacterial organisms. Good quality tobacco is also grown on these soils of high acid reaction, and the condition of the original plots treated in 1931 should be such that a limit to both organism and plant can be studied under field conditions during 1932.



### A Study of Plant Treatment for Control of the Black Shank Disease of Tobacco on Farm of Roy Lewis, Walkertown

Plants on soils heavily infected with *Phytophthora nicotianae* were treated with various chemicals, which were poured around the stems and roots five days after plants were set June 10. With the moisture available in the soil, the solution diffused into the soil beyond the root system, from the pockets in which solutions were poured around the stem.

The results were obtained on three different occasions, July 9, July 17, and September 19, and are given in Table I. These results are averages from two plots each of 100 plants transplanted and treated in different parts of the field. None of the treatments gave outstanding reduction of the disease. The copper and sulphur compounds reduced infection 11 to 17.5 percent. They probably would have given even more efficient reduction if another application had been given about July 15, since there was much less infection on plots where copper and sulphur compounds were used than on plants not treated at that time. A compound containing 35 percent hydroxymercurichlorophenol used at the rate of 1-200 and zinc sulphate used without lime at the rate of 1-200 caused injury, which resulted in greater loss from the causal fungus. The results of these tests indicate the need for further trials with greater strengths of the chemicals giving reduction of infection and on two or three more applications at different periods during the season.

PLANT TREATMENT FOR CONTROL OF BLACK SHANK DISEASE OF TOBACCO ON FARM OF ROY LEWIS, WALKERTOWN—1931

Chemical	Strength	Diseased July 9 Average Percent	Diseased July 17 Average Percent	Diseased
Lime Finish (Finishing).....	1-10	1.5	20.5	60.5
Hydroxymercurichlorophenol 10 per cent mercury.....	1-200	4.0	19.5	61.5
Hydroxymercurichlorophenol 35 per cent mercury.....	1-50	13.0	38.5	77.0
Emulsified Phenol.....	1-500	11.5	41.0	86.5
Emulsified Cresol.....	1-500	11.5	23.0	68.0
Check.....	.....	8.0	17.5	59.0
Ferrous Sulphate.....	1-100	6.0	9.0	46.5
Magnesium Sulphate.....	1-100	8.0	12.0	48.0
Colloidal Sulphur.....	1-500	2.5	6.0	47.5
Calcium Sulfide.....	1-100	2.5	9.5	48.0
Copper Sulphate Lime.....	1-200	5.0	11.5	42.5
Oxy Bordeaux.....	1-20	2.5	5.5	41.5
Copper Carbonate.....	1-200	8.0	10.0	49.5
Zinc Sulphate.....	1-200	13.0	39.0	80.5
Potassium Permanganate.....	1-500	14.0	38.0	54.5
Colloidal Calomel.....	1-100	13.0	32.5	58.0
Check.....	.....	7.5	25.5	64.5

### A Study on Plant Treatment for Control of Root Rot of Tobacco Caused by *Thielavia basicola*

These studies consist of plant root treatment during transplanting and treatment of the soil previous to transplanting. The soils used in these

tests were Cecil sandy loam on Boswell's farm near Summerfield, and Durham sandy loam on the Aldridge farm at Haw River. The two soil areas are known to produce diseased plants in other years. The hydrogen-ion reaction of the soil at the beginning of the study on the Boswell farm varied from pH 6.0 to pH 6.9, and on the Aldridge farm was uniformly pH 6.5.

Commercial acetic acid at the rate of 1-200 and 1-500, and commercial sulphuric acid at the rate of 1-200 and 1-500 applied during transplanting caused severe injury, although previous tests in pots indicated that the plants would tolerate these strengths. Super phosphate at the rate of 1 pound to two gallons of water greatly stimulated the plants under drought conditions. When examined July 16 plants transplanted and watered with acid phosphate solution on May 19 showed an average height of 3½ feet in comparison to 2 feet growth for plants receiving plain water. Nitrate of soda at the rate of 1 pound to 50 gallons of water showed similar stimulating effects.

Observational studies on the behavior of the disease in this State indicates that the greatest amount of injury occurs soon after the transplanting period in May, and that recovery to a sufficient degree to produce excellent crops is seen in seasons when precipitation is light. Badly diseased plants in two fields were stimulated by turning soil up high on the stems, forcing secondary root formation, and an excellent yield was obtained from plants so severely diseased from the loss of primary roots during the early part of June that heavy losses appeared inevitable. It would seem from these tests that a practical solution of the black root rot problem may be obtained by plant stimulation, especially where soils have not received limes in previous years. Ground sulphur at the rates of 300 and 600 pounds to the acre applied to the soil on March 18, had reduced the hydrogen-ion from pH 6.0 to pH 5.2 and pH 5.0, respectively, by April 24. Hydrated lime at the rate of 1,000 pounds to the acre gave a hydroxyl-ion reaction of pH 7.8. On July 16 the sulphur treated soil of both 300 and 600 amounts showed regular plant growth of 14 inches in height in comparison with 8½ inches for plants on the lime plots. Sixty percent of plants on limed plots were dead. The untreated plots showed slightly weaker growth than the sulphured plots. These differences prevailed throughout the season. The results of these studies definitely show that the uses of hydrated lime, and possibly any lime that would cause an alkaline soil reaction on tobacco soils, is certain to cause failure of the crop when the causal organism of black root rot is present.

#### **A Study of Plant Treatment for the Control of Black Rot of Sweet Potatoes**

It was shown previously that the causal organism of black rot lives over on the plant stem, where conditions during the summer are not favorable for its development to the point of killing or seriously injuring the plant. These studies do not indicate any suppression of yield on plants infected by this organism. The low temperatures of the soil developing in late summer revive the activity of the fungus, which first attacks potatoes nearest to the infected stem (Figure 10), but the development of mycelium and brown spored conidia were prominent around the stem and sometimes on potatoes which did not show symptoms of disease

at the time of harvest. Laboratory tests in which heavily inoculated potatoes were buried two inches in sand indicated an unlimited range of fungous activity in the soil, since the organism developed at the surface and throughout the upper soil surface in abundance. This was readily determined in the white sand by the distribution of the dark colored fungous parts.

Control studies were conducted with the White Jersey variety on light sandy soil. Copper, mercury, calcium and sulphur compounds were applied to the stems and roots of the plant just previous to transplanting, and immediately after the parts were inoculated with spores of the fungus. The results at the time of harvest and after sufficient storage period for the disease to develop on infected potatoes are given in Table I.

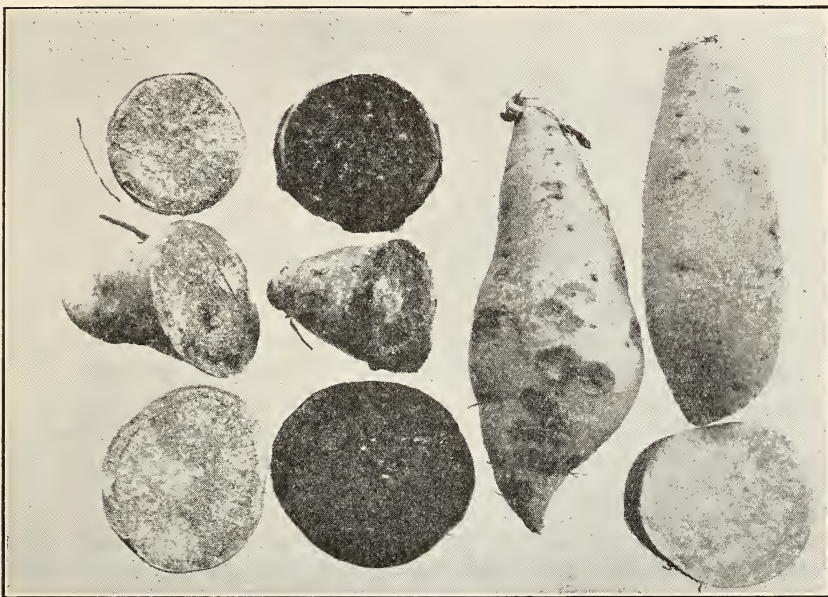


Figure 10.—Sweet potato showing stages in the development of black rot disease causal fungus. Parts on left show grayish masses of hyaline conidia spores three days after inoculation. Next parts show deep brown to black mycelium, conidia and perithecia with grayish masses of ascospores exuding at top and held together by a mucilaginous substance. Spots on whole potatoes six days after inoculation, and healthy potatoes.

The plants inoculated when set had 58.6 percent black rot infection. Usually 100 percent infection would result from an inoculation with this active parasite, but soil temperatures becoming warmer by June 15 when the experiment was started, is suspected as being responsible for the healthy condition of 41.4 percent of the plants, since planting trials on different dates showed that plants set May 1 and 15 were more severely attacked than those set June 1 and 15. Those set in July were nearly free of black rot. Experiences in handling the fungus in the laboratory indicate that it becomes inactive during the summer. The temperature conditions are the suspected cause of this phenomenon. The plants that were not inoculated remained free of black rot.



The copper carbonate especially 1/5 and 18 percent dust compound, were effective in controlling the fungus. There was slight infection where 1/10 copper carbonate was used. This solution was prepared from the 18 percent dust. The Bordeaux mixtures reduced infection of the stem to less than 2 percent. Sulphur and cresol mercury held infection to 2.6 and 2.5 percent, respectively. Chlorophenol mercury and lime were less effective and infection amounted to 8.9 and 12.5 percent respectively.

The low percentage of diseased potatoes at the time of harvest is one of the serious drawbacks to proper interpretation of field control studies on this disease because the plant stems are frequently badly infected, and the potatoes on the diseased plants may sometimes be free from the disease. The infection of potatoes is readily determined, however, when potatoes from the diseased plants are stored for four or more weeks. As much as 100 percent potato infection is known to occur in this manner, when only one to two percent of the potatoes are diseased at the time of harvest. In this test 80 percent of the potatoes developed black rot spots in storage in comparison with 2.9 percent in the field. The infection was 15.8 percent where copper carbonate 1/10 was used, and on plants that showed only 1.3 percent stems diseased, and .2 percent diseased potatoes. It is evident from these results that complete control of the fungus and the prevention of stem infection is essential in order to obtain satisfactory practical control. These results are encouraging, but are not accepted as conclusive since further studies will involve natural soil infection and a wider range of soil types and conditions.

#### **A Study of the Effects of Certain Chemicals on *Ceratostomella fimbriatum*, the Causal Organism of the Black Rot Disease of the Sweet Potato**

The causal organism of sweet potato black rot has been studied extensively in the laboratory during the year. It was found that the fungous growth was difficult to maintain during the summer period, but during autumn, winter and spring seasons heavy growth on cut and natural surface was obtained. The various types of spores, beginning with the hyaline conidia in chains, the brown conidia, and later the black perithecia with ascus spores forming at the top of the neck of the perithecia were readily developed. When freshly cut potatoes were inoculated with the hyaline spores and maintained at a room temperature of 70 to 80 degrees Fahrenheit, and in a closed chamber of relatively high moisture, the disease developed well in three days. It developed three days later on potatoes that were not cut (Figure 10). The excellent growth of the fungus and the readiness with which the disease developed was accepted as sufficiently near the optimum growth as would be necessary for determining the effects of chemicals on the fungus when studied on the host in the most natural stage at which infection normally occurs. The potatoes were inoculated immediately after the fresh cuts were made and were treated with various chemicals immediately after inoculation. The effectiveness of the chemical on the fungus was sometimes evident in ten days and very definite after 30 days.



THE EFFECT OF VARIOUS CHEMICALS ON THE CONTROL OF BLACK ROT OF SWEET POTATOES IMMEDIATELY AFTER INOCULATING ROOTS AND STEMS WITH THE CAUSAL FUNGUS JUST PREVIOUS TO TRANSPLANTING IN THE FIELD

Treatment	Amount and Strength	Stems Infected Percent	Potatoes Infected Percent	Potatoes Badly Infected Percent	Potatoes After 4 Weeks Storage Black Rot Percent
Check.....	.....	58.6	2.9	1.9	80.0
Copper Carbonate.....	1-5	0	0	0	0
Copper Carbonate.....	1-10	1.3	.2	.2	15.8
Copper Carbonate.....	18% dust*	0	0	0	0
Bordeaux Mixture.....	50-50-50	0	0	0	0
Bordeaux Mixture.....	20-20-50	1.8	1.8	1.8	25.2
Bordeaux Mixture.....	10-10-50	1.1	0	0	8.3
Sulphur.....	Dust	2.6	0	0	7.9
Chlorophenol Mercury.....	2%*	8.9	0	0	28.2
Cresol Mercury.....	2%*	2.5	0	0	32.1
Lime.....	Dust	12.5	0	0	65.1
Check.....	.....	0	0	0	0

\*Represents the copper or mercury percent.

Copper sulphate 1/50, copper acetate 1/10, copper carbonate 1/10, and dust mixtures 18 percent, mercuric chloride 1/500, alkaline chloramine 1/20, ethyl mercury chloride 1/1000, Formaldehyde 1/10, sulphuric acid 1/25, and sulphur dioxide liquid gas of one minute exposure, controlled the fungus, but all caused severe injury to the potato, except sulphuric acid and copper carbonate. Further tests with the acids and copper carbonate are being conducted on plants and potatoes. Bordeaux mixture up to the strengths of 20-20-50 suppressed the fungus but did not indicate a satisfactory toxicity to completely control the fungus. Boric acid used as a powder prevented infection, but caused severe injury. This injury was less pronounced on the whole uncut potato than on the cut surface. Formaldehyde 1/100 used for 60 minutes treatment was effective in controlling the fungus, but infection developed when the same treatment was applied for 50 minutes. The organic mercury compounds when used in inert so-called dust materials and applied in powdered form readily controlled the fungus, but all damaged the potato under the high moisture conditions which favor the best fungus growth. Sodium bisulphite applied as a fully concentrated chemical prevented the development of the fungus, but caused injury to the cut potato. It is very evident from these results that a satisfactory treatment for destroying the fungus without injuring the potato may be difficult to obtain. The combinations of the effective chemicals and trials under normal storage conditions in which the optimum conditions for fungous growth are not always present are yet to be investigated.

Heavy applications of hydrated limes in dust and 1/10 solution strength did not affect the organism. Colloidal sulphur as a heavy dust application likewise did not control the fungus. Potassium permanganate in concentrated solution was not effective.

### The Effects of Certain Chemicals on Sweet Potatoes When Used in Various Amounts

In studying the use of chemicals on fungi that cause rots in storage and diseases in the field different degrees of toxicity were noted, which somewhat interferes with control, that may otherwise be readily obtained. It seems worthwhile at this time to give some data on the character of the injury, in view of the fact that growers sometimes use certain of the chemicals in storage houses as a means of disinfecting. Others are used for treating potatoes just before bedding. The burning of sulphur in houses is sometimes practiced but is found to be very harmful if done after the potatoes are stored, since in the presence of moisture the fumes of sulphur dioxide combine with the water to form sulphureous acid, a very toxic dehydration chemical. The symptoms of injury occurring as sunken circular areas at the point where new plants develop and where rootlets develop from the potato. The tissues in injured areas are lighter in color than those of the normal parts due to a bleaching of the cells. Formaldehyde, when used stronger than 1/200, and when not washed from the potatoes and when potatoes were not dried well after treatment, caused a similar type of injury. Again the injury is most severe at the point where channels open to the primary bundles. These two chemicals used in the amounts to which would be useful in controlling the causal fungi of disease, indicate that the epidermal and periderm tissues are resistant to the chemicals if not injured by mechanical means. When formaldehyde is used for seed treatment, although it is not recommended, injury of this type may easily be prevented by washing with water after the necessary treatment is given. Mercuric chloride and copper sulphate, copper sulphate to a more pronounced degree, develops injury on any part of the potato, causing circular sunken spots of a dehydration character. These two salts may show even greater injury on healthy epiderm and periderm tissue than at points where rootlets and new plants develop on the potato. The copper sulphate spots produced with 1/400 strength may not injure beyond the periderm, and injured tissue develops more slowly than does spots caused by other chemicals given above. When an equal quantity of lime and copper sulphate were used in strengths up to 1/10, no injury developed. Potatoes treated with the copper compounds, especially when not combined mechanically with lime, become heavily infected with a *Trichoderma*-species indicating the production of a suitable condition for this fungus. When mercuric chloride 1/1000 was used for 15 minutes and the potatoes were dried immediately afterwards, no injury occurred, but when potatoes received the same treatment and were maintained in a chamber of a relatively high degree of moisture for two days, injury was severe. This explains differences in the germination or production of new plants from potatoes treated with mercuric chloride when excellent germination is obtained after the treatments and poor germination in other instances. Potatoes treated, placed in the desired arrangement in the beds and allowed to dry thoroughly before covering, are resistant to the chemical. An unidentified bacterial organism persisted in growing on potatoes treated with mercuric chloride and the organic mercury compounds. It does not appear to be more than a weak parasite.

### The Susceptibility of Different Sweet Potato Varieties to the Scurf Disease

There are varieties of sweet potatoes which are seemingly more resistant to *Monilochaetes infuscans* than others. The difference in infection of potatoes is especially noted some seasons. Laboratory, greenhouse, and field tests were conducted for the purpose of determining the relative varietal susceptibility.

Tests were conducted in the greenhouse with all of the important commercial varieties and strains, including Red Jersey, White Jersey, Vineless Jersey, Short Horn, Nancy Hall, Miles Yam, Porto Rico, New Gem, Belmont, Norton Yam, and Triumph varieties. Plants of these varieties were inoculated with spores of the causal fungus and transplanted in washed sands. Other plants were set in infected soils. In both tests 100 percent plant infection was obtained, and the few small potatoes formed in the pots were also blackened by the disease. Heavy infection of potatoes of these same varieties was obtained in the laboratory, when inoculated with spores, and placed in moist chambers for four weeks. These tests tend to show no resistance of any of the varieties tested, but field trials were conducted as a further check on the activities of the fungus.

On Cecil, Norfolk, Granville, Hoffman, and Durham sands and sandy loams, the Jersey varieties produce potatoes nearest to the stems. The plants on poor light sands produce potatoes nearer the stems than those grown on more fertile soils of the same type. The Nancy Hall and related varieties also behave in this way, but to a less certain degree, since in sands of the deep phase of the Norfolk series, potatoes of this variety sometimes develop two to three feet from the center of the hill, especially in dry seasons. The Porto Rico, Triumph and Norton Yam varieties produce potatoes further away from the stem than many varieties on these various soil types.

It was previously shown that the stem of the plant is the principal carrier of the causal scurf fungus, and that the soil in this State is a minor source of infection. Even when the soil is infected the development of the fungus on the stem was found to greatly influence the amount of inoculation and the infection of the potato.

The results of the test on Cecil sandy loam soils are given in Table I. The plants were inoculated just previous to transplanting and when harvested all showed 100 percent infection of stems. The amount of slightly infected potatoes varied from 51.3 percent for Yellow Jersey to 73.3 to 77.0 percent for the Red Jersey and White Jersey, respectively. It was 74.5 and 66.1 percent for the Nancy Hall and Miles Yam varieties, respectively. All of these varieties with the exception of Miles Yam, with 18.2 percent badly infected potatoes, showed from 28.0 percent for the Yellow Jersey to 45.7 percent for the White Jersey. The Porto Rico and Triumph potatoes had 36.9 and 27.7 percent infected potatoes, and 19.8 and 16.8 percent badly infected potatoes, respectively. The Norton Yam, which produced many potatoes from 12 to 24 inches from the stem had only 4.4 slightly infected potatoes and 3.0 percent badly infected potatoes, although greenhouse and laboratory inoculation studies showed that the variety is very susceptible. It is shown that the difference in

infection of these varieties is due directly to the distance of the potatoes from the stem, since potatoes on plants of the Norton Yam and others when near the infected stem, became badly diseased. It is, therefore, evident that the infection of the potatoes of the various varieties will vary according to distance of the potato from the infected stem and some extent with seasonal conditions favoring the development and spread of the fungus.

THE SUSCEPTIBILITY OF DIFFERENT SWEET POTATO VARIETIES TO THE SCURF  
DISEASE OF FARM OF S. E. BOSWELL, SUMMERFIELD

Variety	Stems Infected Percent	Potatoes Slightly Infected Percent	Potatoes Severely Infected Percent
Red Jersey.....	100.0	73.3	45.2
Yellow Jersey.....	100.0	51.3	28.0
White Jersey.....	100.0	77.0	45.7
Nancy Hall.....	100.0	74.5	42.9
Miles Yam.....	100.0	66.1	18.2
Porto Rico.....	100.0	36.9	19.8
Triumph.....	100.0	27.7	16.8
Norton Yam.....	100.0	4.4	3.0

A Study of Varietal Resistance to Rot Root Disease of Sweet Potatoes  
in Currituck County

This disease occurs on the light sandy soils in the lower end of Currituck County. It does not occur in the upper end of the same county where the same variety of Yellow Jersey is grown on stiffer sandy loams. It probably is peculiar to the conditions of that section of Currituck County, since observations and reports from other parts of the State indicate that it does not occur in other sweet potato growing areas. The cause of the disease is not known. It resembles the disease reported by Harter called "Mottle Necrosis," but it is not entirely identical. A large number of organisms were isolated from the diseased parts, and inoculation tests were conducted under a variety of conditions, but up to this time the results are negative. The disease develops from July to November, and occurs in both dry and wet seasons.

The 14 varieties, including Porto Rico, Golden Porto Rico, New Gem, Nancy Hall, Short Horn, Miles Yam, Norton Yam, White Yam, Yellow Yam, Vineless Yam, Triumph, Red Jersey, White Jersey, and Yellow Jersey were grown on infected soils. The Jersey varieties were all very susceptible. All other varieties, including the Triumph variety, were highly resistant. The Triumph, Yellow Yam, Nancy Hall, and Porto Rico also gave excellent yields on the infected soils.

A Study of Soft Rots and the Causal Organisms on Late Harvested  
Sweet Potatoes

When potatoes are harvested before low soil temperatures develop minimum losses occur in storage if effective measures are practiced for the control of *Rhizopus nigricans* and *Ceratostomella fimbriatum*. After this



period which may occur at any time after October 15, in this State, heavy losses due to *Pythium* species and to *Mucor* species which cause soft rots, may occur. The losses in the field are often heavy and further decay in storage is sometimes severe and uncontrollable. Potatoes harvested at various periods showed that the losses increase as the season advances, and will be much greater by the first of December than by the first of November. The organisms causing the decay are soil borne, and the low temperatures seem to be optimum for their growth and parasitic activities, since they do not attack until low soil temperatures occur.

B. W. WELLS,  
*Head, Department of Botany.*

## RESEARCH IN HOME ECONOMICS

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The research project in Home Economics has been conducted along the lines outlined in last year's annual report. The two main objects of this study of factors conditioning the living of 35 typically successful farm owner families in Wake County are, first, to discover and analyze factors which lie within the family organization and condition the standard of living, and, second, to adapt the case study method to research with farm families. These case studies are a further step in the attempt to understand and interpret the conditions underlying farm family living, and are a part of the long time program of social research.

A detailed case study requires repeated visits to the home, and these interviews must suit the convenience of the home-maker. As a consequence they are held up at certain seasons of the year, such as tobacco curing and grading times, and other seasons when the homemaker is pressed with extra duties.

With a few exceptions, the greater part of the home visiting has been done, but no results can be reported until all the interviews are completed. After all data have been collected, analyses will be made. The manuscript will then be prepared early in 1932.

No recommendations for future projects can be made until the present study is completed, since it seems wise to base further plans on the finding of this study.

MYRA DEHAVEN WOODRUFF,  
*Associate in Home Economics Research.*

## RESEARCH IN HORTICULTURE

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Research work in the Department of Horticulture consists largely of application of scientific methods to the improvement of horticultural crops and production practices. Genetic and plant breeding methods are being applied to the improvement of the potato, lettuce and squash, raspberry, dewberry, and peach. Systematic and variety test studies, which are a phase of crop improvement, are being conducted with a number of tree and small fruits, many kinds of vegetables, floral crops and ornamental plants to determine the adaptability of the newer varieties to North Carolina conditions.

Physiological, chemical and microchemical methods are being applied to various phases of the nutrition, growth, and reproduction problems encountered with the peach, dewberry, potato, and other crops. These problems and treatment are of a technical nature, but are nevertheless closely related to field and orchard practices of soil improvement and fertilization, growth and yield, cultivation, pruning and harvesting. Similar problems, treatment and applications are found with vegetable and floral crops. Field experimental methods are being used to study differences in cultural and production practices, such as fertilization, green manuring, pruning and thinning. The work is being conducted under the soil and climatic conditions found in different sections of the State, and where the crops and problems are of major importance.

The research facilities of the department have been materially extended by the acquisition of a cold storage unit consisting of a series of three chambers which will be used primarily for physiological investigations of fruit, vegetable and bulb storage, hardiness of apple and peach, for storage of potato and other breeding material and of material for systematic studies of fruits and vegetables. These new facilities in addition to certain new laboratory and greenhouse equipment will materially enrich the research facilities and program of the department in coming years.

A report of the projects which have been grouped according to crop rather than according to importance or methods of attack, follows:

### POMOLOGY INVESTIGATIONS

#### PEACH

**Physiological Studies No. 1.—Nutrition and food storage associated with differences in growth, fruiting and hardiness of the peach.**—C. F. WILLIAMS and J. H. BEAUMONT. Efforts are being made to determine by qualitative and quantitative analysis of the peach tree the proportions of various plant constituents associated with differences in growth, fruiting and hardiness. Nitrogen treatments varying in time and amount have been applied to duplicate experimental plots to induce differential growth and hardiness conditions. Samples for chemical analysis have been taken at stated intervals during the growing and dormant seasons from representative trees of each treatment.

The analysis of the 1930-31 chemical samples is progressing rapidly but is not sufficiently complete to attempt correlations with tree response. However, the following information relative to the seasonal behavior and concentration of various plant constituents has been secured.

The percentage of total nitrogen is relatively high in the developing shoots, but declines rapidly until harvest when the minimum for the year is reached. A slow increase occurs from this time until dormancy, followed by little change during the winter months. A rapid increase occurs during late winter and early spring, continuing through the period of bloom. Changes in wood of the previous season are similar, but much less in percentage amounts.

Applications of nitrogen as nitrate of soda during the growing season are reflected in a higher percentage of total nitrogen in the shoots over the check on the basis of samples collected one month later. The percentage increases are in general proportional to the rate of application.

All trees regardless of the time or amount of application of nitrate, reached approximately the same minimum concentration at harvest. This might indicate the almost total utilization or translocation of nitrogen or a physiological equilibrium between growth and storage which would result in equal concentrations, though perhaps not equal total quantities at this period.

The treatment which gave the greatest increase in percent of total nitrogen during fall and winter was one receiving all of its nitrogen after harvest. Of the plots receiving 3-pound applications of nitrate at one or each of the two different times, the three having the higher percentages of total nitrogen in the shoots at dormancy showed slightly lower percentage amounts in January, while the three having the lower percentages amounts at dormancy had somewhat higher amounts in January. This may indicate a tendency to come to a physiological level during this period.

Higher percentages of nitrogen were usually associated with lower percentages of reducing substances and of acid hydrolyzable material but with higher percentages of sucrose, starch and total carbohydrates.

In some of the low nitrogen plots the percentage of starch reached its summer maximum in August, decreasing from this time until defoliation. This is suggestive that during the long summers, after harvest, trees may actually utilize some of their food reserves before the end of the growing season.

**Physiological Studies No. 2.—Leaf efficiency of the peach as affected by soil moisture and as measured by size and quality of fruit and food storage in the tree.** I. D. JONES and J. H. BEAUMONT. This phase of the peach physiology project, begun in 1931 in cooperation with the Department of Horticultural Crops and Diseases, U. S. Department of Agriculture, is primarily an endeavor to measure leaf efficiency and function; first, by studying stomatal behavior as affected by varying soil moisture and atmospheric conditions; and, second, by determining the relation of leaf function and area to growth of the fruit in size and quality and of the branch in elongation, food storage, and fruit bud formation.

Four soil moisture plots were established in the R. S. Lovering orchard near Jackson Springs, as follows:



- (a) Artificially irrigated plot: Water supplied by hauling from a well when the soil became somewhat dry. Two irrigations were necessary.
- (b) Mulched plot: A 12-inch layer of pine straw was used to conserve the naturally occurring moisture.
- (c) Dry plot: Gain of moisture from precipitation upon the surface was prevented by the use of a complete covering of mulch paper.
- (d) Check or average orchard condition plot: No artificial moisture control.

These treatments were quite successful in maintaining differences in soil moisture. Stomatal movements were followed in the field by examining, microscopically, strippings of the epidermal covering of the under side of the leaf.

**Leaf Area Control:** On these plots the leaf area was controlled by removing leaves or fruit from comparable one-year-old ringed twigs. A few two- and three-year-old branches were also ringed.

The observations and analytical results have not been completed.

**Physiological Studies No. 3.—Protein peptization.**—I. D. JONES. This work was begun during the year and has consisted of preliminary analyses of peach wood from trees differing in nitrate fertilization and vigor. It is felt that a study of the presence, distribution and availability of the various nitrogen fractions in peach tissues will be of great interest, particularly in relation to nitrogen fertilization and soil moisture studies.

**Peach Fertilization No. 1.—In the Sandhills.**—J. H. BEAUMONT, C. F. WILLIAMS, I. D. JONES. The project is primarily a study of the effects of time and rate of nitrogen fertilization on growth and yield of the peach tree, and of time of maturity, size, and color of the fruit. The results indicate that, under the conditions existing in the experimental orchard this year (see also 1930 Report), 6 pounds of nitrate of soda, either as a single or split application, does not give increased yields of fruit over the 3-pound applications. On the other hand, 1½ pounds seem to be insufficient to produce the more desirable type of growth and a high yield. The average yields per tree of the 6, 3 and 1½ pound treatments were 165, 168 and 148 pounds, respectively.

The data indicate that the application before bloom is the most important, the yields progressively decreasing as the time of application is delayed, regardless of the amount applied.

The effect of nitrogen on the time of maturity of the fruit is quite striking. On the 10th day of the 14-day harvest 96 percent of the fruit had been picked from those plots not receiving nitrogen until after harvest; approximately 77 percent from those plots receiving ¾ pound before harvest; 74 percent from those plots receiving 1½ and 2 pounds before; and 65 percent from those receiving 3 and 6 pounds before harvest.

Measurements of trunk circumference, length of terminal and lateral growth, percentage set of fruit buds, vigor and condition of the tree are being secured.

The past two seasons have been abnormally dry and consequently the availability of the nitrogen and the tree response doubtless have varied somewhat from that which might be found in a "normal" season.

The data so far indicate that, with a vetch cover crop, soil conditions and pruning and cultural practices comparable to those employed in the experimental orchard, a 30 pound application of nitrate of soda is better than either more or less than this amount, and that it may be applied as a single application before bloom or as split applications before bloom, and at the time of the June drop with equally good results. It would seem, however, that considering the characteristics of the soil, rainfall, frost, and other factors affecting availability of nitrogen and size of crop that the split application would be preferable.

The young orchard on which further fertilizer and cultural treatments will be conducted has made excellent growth. It is planned to start treatments next year.

**Peach Fertilization No. 2.—In the Piedmont.**—M. E. GARDNER and J. H. BEAUMONT. This project was begun in 1923 at the Piedmont Branch Experiment Station to study the effect of quickly available nitrogen on the growth and production of peach trees. Five trees each of five varieties have received no nitrogen, all other trees have received an annual increase of nitrate of soda. Although the trees receiving no nitrogen have shown a steady but gradual decline, they have maintained surprising vigor and production compared to what might be expected on other soil types. The soil is of the Cecil clay type. In the spring of 1930 nitrate was applied to these trees and they have made quick recovery in both vigor and production.

It will be noted that the trees passed through seven growing seasons, three of them being crop years, without any fertilizer whatever being applied. The average yields in bushels per tree over the period of the study are Hiley .83, Belle, 1.12, Elberta 1.11, Hale 1.02, and Aubert 1.14. The average yields of nitrated trees were Hiley 1.81, Belle 1.55, Elberta 1.75, Hale 1.75, Augbert 1.25.

This project has been discontinued as such, but is followed by a more detailed and comprehensive experiment as outlined below.

**Further Studies on Peach Fertilization in the Piedmont.** A young orchard of two hundred and sixty-one Georgia Belle trees was planted in the spring of 1931 to make further fertilizer and cultural studies. The trees were one-year whips and carefully graded for uniformity. The treatment was uniform for all trees consisting of the application of nitrate of soda and the growing of a summer cover crop of soybeans. The beans were cut in and will be followed by a winter cover of vetch. Treatments will include, (1) cover crop alone, (2) cover crop plus nitrogen, and (3) clean culture plus nitrogen with a natural cover crop, and (4)  $K_2O$  and  $P_2O_5$  on cover crop and clean culture treatments.

**Peach Pruning.—In the Piedmont.**—M. E. GARDNER. This experiment has been handled as outlined in previous reports in that the treatments of heavy, medium and light pruning have been systematically carried out, and yield, circumference and weight of prunings recorded.

This work has brought out several salient points relative to peach growing in the heavy Cecil clay type soils of the Piedmont:

1. It is necessary to establish a strong tree by proper selection and spacing of scaffold branches.
2. It is impractical to attempt to keep trees low enough for ground pickers by heavy pruning.

3. Trees should not be planted closer than twenty-two feet.
4. It is possible to grow vigorous and productive trees with nitrogen alone without the aid of a planted cover crop.

## APPLE

**Apple Fertilization No. 1.**—Time and amount of nitrate fertilization of apples.—M. E. GARDNER and J. H. BEAUMONT. This experiment was planned to show the nitrogen requirements of apple trees under orchard conditions in Western North Carolina. Single and split fall and spring applications were made. The total amounts of nitrate applied vary from 4 to 12 pounds per tree. Significant results are not expected for a period of years because it will require considerable time for the trees to respond to the treatments. Unusually severe weather conditions were unfavorable to the experiment this year.

**Apple Fertilization No. 2.**—M. E. GARDNER. This orchard is seven years old and has not borne sufficiently to attribute any differences to the effect of the various fertilizer treatments.

In 1927 a severe windstorm so damaged the roots of the trees that many have died. In consequence, it seems advisable to reorganize or discontinue this experiment.

**Apple Pruning Investigations.**—M. E. GARDNER. An unusually favorable crop year has given results in line with those of previous years. Total yields favor the lighter systems of pruning.

In the past no attempt has been made to determine percentages of different grades resulting from the three pruning treatments, owing to lack of equipment. Such equipment was available late this year and it was possible to grade Winesaps. In the future all varieties will be graded, except possibly Delicious, which will aid materially in interpreting results. The grades for Winesaps are given in the following table:

TABLE I—PERCENTAGES OF DIFFERENT GRADES RESULTING FROM PRUNING TREATMENTS

Pruning Treatment	Percent Above 2½ Inches	Percent 2½ Inches	Percent 2¼ Inches and Below
Heavy.....	32.35	36.76	30.88
Medium.....	28.63	41.49	29.87
Light.....	20.24	34.71	45.04

It is apparent from the data for Winesap that with the lighter systems of pruning and resultant increased yield the size of fruit falls off materially.

## FRUIT VARIETY TESTS

Variety test studies were reorganized in the spring of 1929 and have been conducted as outlined in previous reports, i.e., systematic notes have been kept on the performance of all varieties under test at the Central, Piedmont and Mountain Stations.

To the test have been added three varieties of peaches from Canada, seven varieties of peaches, plums and apricots from the Division of Foreign Plant Introduction, United States Department of Agriculture, and twenty-three varieties of Maraschino cherries from H. P. Gould, of the United States Department of Agriculture.

## PECAN

**Tree Performance of Bearing Pecans.**—J. H. BEAUMONT, M. E. GARDNER, ROBERT SCHMIDT. Seventeen years yield records of pecans at the Upper and Lower Coastal Plain Stations have been summarized and will be reported during the coming year. These data show that the pecan is better adapted at the Lower Coastal Plain Station than at the Upper. Fewer crop failures have resulted and the average yield per tree is consequently greater. The pecan yields indicate a biennial bearing tendency which, however, is interrupted by seasonal conditions. Attempts to determine what climatic factors were the more important are being made.

**Pecan Cracking Test.**—M. E. GARDNER. This test covers a period of twelve years and was outlined to make a systematic study of the internal and external characteristics of nuts of varieties growing in the Upper and Lower Coastal Plain regions of the State. Each bearing year one pound of nuts was selected from each variety at both the Lower Coastal Plain Station at Willard and the Upper Coastal Plain Station near Rocky Mount.

This test has been discontinued and the final report is now being prepared.

**Physiological Study of Fruit Bud Formation in Relation to Annual and Alternate Bearing.**—J. H. BEAUMONT. This project is dormant because of lack of time and assistance to carry it on. It is quite important, however, and the study should be made particularly on those varieties on which continuous yield records are available.

## SMALL FRUITS

### DEWBERRY

**Effects of Summer Pruning.**—C. F. WILLIAMS. Work during the past year has been directed to systems of summer pruning for the purpose of securing the best growth of fruiting canes. One of the most serious difficulties in dewberry growing has been the failure to obtain satisfactory growth of fruit canes due to weather conditions, disease, or both. The extreme dry weather during the summer of 1930 quite generally limited cane growth so that development of canes was below normal on all plots.

On July 1 the three methods of summer pruning employed in 1930 were repeated in comparison with the growers' practice which consisted of cutting off all canes at the surface of the ground. The four treatments are as follows:

1. Regular vineyard practice.
2. Cutting all canes at the top of crown, usually 1 to 2 inches below the surface of the ground.
3. Removal of old fruit wood, and pruning spring canes to 3 or 4 buds, usually about 10 to 12 inches above ground.
4. Removal of old fruit wood, leaving all healthy spring canes unpruned.



It was found that removal of canes at the crown greatly reduced the number of diseased canes due to cane blight and that, although the first year of such pruning reduced both the number of canes and the yield, the second year the number of canes and yield were greater than the check. Pruning the canes high in order to get rapid development of canes increased the number of canes and the yield the first year but the number of diseased canes increased likewise. The following year the yield was reduced below that of the check due to the number of diseased canes. Results from leaving the spring canes unpruned were unsatisfactory due to mechanical and other injury.

**Studies on Tip Layering.**—C. F. WILLIAMS. Studies on tip layering show that both moisture and absence of light are necessary for rooting, tips not rooting in the dark if the medium was dry nor in the light if the medium was moist. Neither position nor contact with the soil had any effect independent of light and moisture. No great accumulation of starch prior to rooting was found. Starch is present in only the undifferentiated pith at the tip and in the starch sheath, practically none occurring in the central pith. Similar starch distribution was found in leafy shoots. Starch grains in dewberry canes were found to be isotropic while those in storage roots were only faintly doubly refractive. Such a condition has been reported in a few instances only.

Tip layered canes that were severed at the crown of the mother plant were supported and fruited by the roots at the tip.

**Dewberry Breeding.**—C. F. WILLIAMS. Crosses of Young and Austin spineless made in 1930 were set in the field this year and have made satisfactory growth. Of 745 seedlings surviving, 334 are thornless.

**Raspberry Breeding.**—C. F. WILLIAMS. Ninety-six seedlings of the cross *Coreanus* sp. x Latham fruited during the 1931 season. These plants show good vigor and disease resistance as well as adaptation to climatic conditions. Fruit of many of them was of good quality, very much like red raspberry but slightly more acid. Six were especially promising with fruit of high quality, sweet with a subacid flavor. The berries of these averaged about  $\frac{5}{8}$ " in diameter and were medium firm. These will be propagated and tested in different parts of the State.

Seventy-three seedlings of *Coreanus* x Cumberland fruited but show little promise. Fruit was inclined to be small and dry, and the plants subject to cane and leaf disease.

## STRAWBERRY

**Strawberry Variety Studies.**—M. E. GARDNER. Of the seventeen varieties included in a test of strawberry varieties at the Mountain Station, Warfield and Premier have been consistent high producers. The highest yields recorded occurred in 1928 when Warfield produced 7,600 quarts per acre. The same year Premier produced 5,650 quarts.

It is interesting to note that Missionary and Klondike, which have been the standard varieties in the eastern strawberry section of the State, have not done well in the mountain section in comparison with the performance of other varieties. (See Table II.)

The table gives the average yields over a four-year period together with other data. Due to drought, yields were very low during one year of the test.

TABLE II—STRAWBERRY VARIETY TEST, FOUR-YEAR AVERAGE

Variety	Season	Resistance to Disease	Vigor	Yield per Acre Quarts
1. Warfield.....P.....	5/23, 6/17	Resistant	Good	4,204
2. Premier.....	5/22, 6/16	Resistant	Very good	4,092
3. Sample.....P.....	5/25, 6/16	Light Leaf Spot	Good	3,076
4. Dr. Burrill.....	5/23, 6/15	Light Leaf Spot	Fair	2,788
5. McAlpine.....	5/27, 6/17	Medium Leaf Spot	Good	2,456
6. Big Late.....P.....	5/27, 6/16	Light Leaf Spot	Good	2,340
7. Steven's Late Champ'n.	5/27, 6/15	Light Leaf Spot	Good	2,181
8. Senator Dunlap.....	5/22, 6/16	Resistant	Good	2,180
9. Missionary.....	5/21, 6/13	Light Leaf Spot	Good	1,960
10. Excelsior.....	5/21, 6/9	Resistant	Good	1,933
11. Gandy.....	5/30, 6/17	Light Leaf Spot	Good	1,928
12. Aroma.....	5/23, 6/15	Light Leaf Spot	Medium	1,868
13. Chesapeake.....	5/27, 6/16	Medium Leaf Spot	Good	1,816
14. Big Joe.....	5/27, 6/16	Resistant	Good	1,795
15. Klondike.....	5/22, 6/15	Light Leaf Spot	Good	1,429
16. Wm. Belt.....	5/28, 6/16	Heavy Leaf Spot	Weak	1,440
17. Nick Ohmer.....	5/26, 6/15	Medium Leaf Spot	Weak	1,067

P=Pistillate.

\*Soil Type=Porter's Loam.

Altitude=2200 feet.

It will be noted that Warfield, Sample and Big Late are pistillate and therefore will not produce when planted alone or together. To overcome this, a pollen producing variety such as Premier, Dr. Burrill, or Senator Dunlap should be planted in every third row when using the pistillate or unfertile varieties.

#### Strawberry Investigations No. 1.—Fertilization and Cultural Systems.—

ROBERT SCHMIDT and J. H. BEAUMONT. These investigations are being made on the farm of Mr. J. T. Albritton, near Mount Olive. Comparisons are being made of three different systems of culture: viz., the hill system, consisting of plants set 12 inches apart and not allowed to make runners; the narrow matted row, consisting of the usual matted row from 12 to 15 inches wide; and the "Albritton system," in which a single row of plants are set in the spring and the runners trained so that they form a row of plants on either side of the mother plants. When the young plants are established the mother plants are cut out leaving in effect a double row of plants about 6 to 8 inches apart in the row with rows 12 to 15 inches apart. Three varieties, Klondike, Missionary, and Blakemore, were tested under each of these systems in 3 replicate plots of 1/250 acre each.

Results for the year 1931 show that Blakemore gave the best yields under each of the three systems and that the Albritton system was slightly better than the narrow matted row, with both of these systems producing much greater yields than the hill system.

TABLE III—COMPARISON OF DIFFERENT SYSTEMS OF CULTURE FOR STRAWBERRIES

Variety	*Yield in Crates per Acre		
	Hill System	Narrow Matted Row	Albritton System
Klondike.....	120.5	198.0	207.0
Missionary.....	88.0	244.5	223.5
Blakemore.....	150.0	273.5	345.0

\*Yield of No. 1 grade berries.

A series of fertilizer tests, using different formulae and different dates of application were also carried on in this same field. Results for the season of 1931, are not conclusive.

**Strawberry Investigations No. 2.—Age of Plant in Relation to Flower and Fruit Production.**—E. B. MORROW and J. H. BEAUMONT. In the summer of 1930 strawberry runner plants of three varieties were pegged down at approximately 2-week intervals, beginning June 2. In 1931 the flowers and fruits on these plants were counted and later as the fruit was harvested, it was counted and weighed. Figure 1 illustrates the manner in which the plants were handled and something of the behavior. The data show that the older plants, i.e., those rooting earlier, were much more prolific than those rooting later in the season, there being a marked decrease in flower and fruit production on plants rooting after August 15. Of the three varieties tested the Blakemore produced many more flowers and fruits per plant than did Missionary and Klondike. Blakemore plants likewise fell off in number of flowers and fruits per plant very rapidly after August 15, and the later formed plants produced less flowers than those of Missionary or Klondike.

TABLE IV—YIELD PER PLANT, SIZE OF BERRIES, AND CALCULATED YIELD PER ACRE OF PLANTS ROOTING AT DIFFERENT PERIODS

Date Pegged	Weight of Berries per Plant in Ounces			Size of Berries—(No. per 22-Ounce Quart)			Calculated Yield per Acre (32-Quart Crates)		
	Blake-more	Klon-dike	Mis-sionary	Blake-more	Klon-dike	Mis-sionary	Blake-more	Klon-dike	Mis-sionary
MP.....	9.35	7.17	8.75	109	104	118	396	305	373
6/2.....	10.00	4.11	6.53	101	98	109	426	175	278
6/16.....	9.53	5.70	8.08	92	105	118	406	243	344
7/1.....	8.61	4.42	6.63	101	107	125	367	188	283
7/14.....	8.35	4.62	7.63	96	103	116	356	197	325
8/1.....	7.64	4.13	6.38	94	101	115	326	176	272
8/14.....	7.22	3.95	5.86	89	104	109	308	211	250
9/1.....	5.60	3.99	5.38	84	98	109	239	213	229
9/15.....	5.26	4.43	3.96	78	95	102	224	189	169
10/1.....	3.58	3.78	4.75	82	92	88	153	161	202
10/18.....	3.34	3.40	3.00	82	88	94	142	145	127
11/3.....	2.13	1.62	1.54	67	84	105	91	69	66

The size and weight of fruit was in favor of the Blakemore.



It was noted that plants showing the "strawberry dwarf" disease were only approximately half as productive of flowers as healthy plants which emphasizes the importance of this disease and of precautions that should be taken to avoid infestation.

These studies have a direct and important bearing on the time that the old strawberry bed should be renovated in that this operation cannot be done until after harvest, and often is delayed until late in July or August, thus giving the young runner plants but a short time to root and to develop. They have a bearing also upon the cultural practice of thinning out the immature and unfruitful plants, thus giving the larger and more prolific plants a greater reserve of soil moisture and nutrients which is reflected in size and quality of fruit.



Figure 1.—Two Blakemore plants each pegged August 1, 1930 and photographed May 11, 1931. Plant on left had 68 flowers and fruits, and that on right had 56.

## OLERICULTURE

**Potato Breeding.**—J. H. BEAUMONT, M. E. GARDNER, ROBERT SCHMIDT. This project is being conducted in cooperation with the Department of Horticultural Crops and Diseases, United States Department of Agriculture.

Yield tests of the Katahdin variety were conducted in the "early" and in the "late" potato sections. The yields from two tests in the "early" section indicate that when dug with Cobbler the Katahdin will not yield as much. When dug at maturity the Katahdin will yield as much or somewhat more than Cobbler. Compared to home grown Cobbler, one test showed the Katahdin to be considerably superior. The Katahdin is 18 to 20 days later than Cobbler, and the tests this year indicate that it



cannot compete satisfactorily with Cobbler in this section unless it were to replace the later crop of Cobblers grown from "home grown" seed.

In Western North Carolina the average yields of five tests indicate the Cobbler and Katahdin to be approximately equal in yielding ability of U. S. No. 1 grade. Total yields were in favor of Cobbler. The Katahdin proven to be far superior in average size, shape, and attractiveness. Tests will be continued and a seed stock built up for distribution next year.

Tests of 13 numbered varieties at the Mountain Station show that the four highest yielding last year were also high this year. The two lowest yielding varieties were low again this year. The four high yielding varieties will be increased for more extensive test and the two lowest discarded. These tests indicate also that the Green Mountain and Rural are superior to the Cobbler at the Mountain Station.

Six hundred and thirty-four selections were grown at Newland in second test plots. Ten to fifteen percent of these seemed outstanding in one or more respects and will be grown in larger plots next year.

Approximately 10,000 seedlings were grown in the greenhouse at Raleigh and transplanted at the Mountain Station. Seasonal conditions were adverse in general, and the number of selections secured was less than anticipated. This material consisted of inbred lines and other genetic material as well as a number of commercial crosses.

**Lettuce Investigations.**—ROBERT SCHMIDT. Tipburn was severe this season and selections which gave promise of being resistant last year seemed to have little or no resistance this year.

During the 1930 season a number of large leafy off-type plants occurred in the plots. The off-type plants did not form heads. Seed was saved from these plants and grown in the field this year. Some of the resulting plants were large with firm heads and rough, coarse leaves. Others resembled a large type of Cos lettuce. Some did not head at all. Seed was saved from the heading types for further observation.

Figure 2 illustrates the original off-type plant, while Figure 3 shows one of the large heads produced this year from seed saved last year.

At Wilmington, field plot tests with lettuce were made using more concentrated fertilizers than are normally used in that section. The normal fertilizer used for lettuce is a 7-5-7 (PNK) mixture, used at the rate of 2,000 pounds per acre. This formula was used as a check. Treatments consisting of a 12-5-7 (PNK) mixture, equivalent amounts of Ammophosko analyzing 24-12-12 (PNK), Nitrophoska, analyzing 30-15-15 (PNK), and 10 tons of stable manure with 2,000 pounds of the standard 7-5-7 fertilizer, were applied on replicate plots.

The greatest number and the largest heads were cut from the plots receiving manure. Ammophosko seemed to have an injurious effect and gave the least number of heads cut per plot. The color of the plants on the Ammophosko plots was poor. The 12-5-7, 7-5-7, and Nitrophoska plots showed very little difference.

In the trial of several strains of the New York variety, Morse's Strain No. 5084 still proved to be the earliest heading strain of this variety under our conditions. Earliness is an important factor in the production of the Iceberg type of lettuce in Eastern North Carolina.

**Vegetable Fertilizer Project.**—ROBERT SCHMIDT and J. H. BEAUMONT. Although a uniform application of a 4-2-2 (PNK) fertilizer was used on



Figure 2.—Off-type Lettuce Plant.



Figure 3.—One of the large heads of Lettuce produced from seed saved from previous year.



all plots of both sections of the project field, the crops of cabbage and spinach planted in the fall of 1930 were practically total failures. There seems to be no good explanation for this condition. In the spring of 1931 Irish potatoes were planted on the section of the field which was planted to sweet potatoes last year, and sweet potatoes planted on the section which grew Irish potatoes last year. The total yield per plot as obtained this year would indicate that there is very little correlation between the yields of Irish potatoes and sweet potatoes under the same soil conditions. However, the weather conditions were somewhat different for the two crops.

**Vegetable Trial Garden Project.**—ROBERT SCHMIDT and M. E. GARDNER.

During the season of 1931 a large number of varieties and strains of vegetables were grown on the horticultural farm at Raleigh for the purpose of checking up on the new strains and varieties being offered by seedmen.

Of twenty-five varieties and strains of tomatoes, Marglobe and Break-O-Day gave the best performance, being wilt resistant as well as vigorous growers, and producing a very desirable type of fruit. Hastings Extra Early Prolific was the first variety to ripen, followed closely by Earliana, Penn State Earliana, and Extra Early Mascot.

In the tests of pepper varieties, Ruby King again gave the best results. California Wonder and Early Giant were also good.

The Hales Best variety of Muskmelon, Strains No. 36 and No. 112 of the Rocky Ford Seed Breeders Association showed that they are well adapted to North Carolina conditions. Early May, Hearts of Gold, and Superfecto are also good. Hales Best and Early May ripen early and are good shippers, which are desirable characteristics.

Twenty varieties of sweet corn were grown this year, all varieties performing well so far as yield was concerned. The earliest variety tested was Golden Gem. However, this variety as well as other early varieties such as Golden Bantam, the Burpee, Early Market, and Vaughan's Earliest has very small ears and the corn ear worm damage is so severe that most of the crop is worthless. These varieties may be planted later in the season, thereby escaping a great deal of worm injury. Second early varieties such as Golden Bantam Evergreen, Mills Golden Sunrise, Henderson's Goldenrod and Mills White Sunrise, were of excellent quality, had larger ears than the earliest varieties, and were not so badly damaged by the ear worm.

## FLORICULTURE

**Variety Tests with Floral Crops.**—G. O. RANDALL and J. G. WEAVER. The variety tests with floral crops, as previously reported, including roses, herbaceous perennials, tulips, narcissi and iris, have been continued during the past year. The varieties reported as outstanding in the 1930 annual report continued to hold this position during the year.

The bulb yield records with tulips are extensive enough to justify a report at this time pertaining to the comparative increase in yield of bulbs of the different varieties in the test. It is of interest to note that only a limited number of varieties of tulips have increased in yield of bulbs. Following is a list of varieties which have either held their own

or increased in yield during a three-year period under the conditions of this experiment:

*Early Single*—Diana, Fred Moore, Montresor, and Roos Van De Kema.

*Cottage*—Gesneriana Major, Inglescomb Pink, Inglescomb Yellow, John Ruskin, and Pride of Inglescomb.

*Breeders*—Alcidia, Bacchus, Dryad, and Feu Ardent.

*Darwin*—Baronne De LaTonnaye, Bartigon, Clara Butt, Duchess of Hoenberg, Herodiade, King George V, Mr. Farncombe Sanders, President Harding, Pride of Haarlem, Prince of the Netherlands, and The Bishop.

*Byblooms*—Belle Irlandaise.

*Rembrandt*—Iduna.

**Variety Tests with Floral Crops Under Glass.**—G. O. RANDALL and J. G. WEAVER. Variety tests of roses and carnations are being conducted under glass with the object of comparing newly introduced varieties with established standard varieties, with reference to yield, quality of flower and stem, and vigor of plant.

Unfortunately no report on the rose variety test can be made this year for the reason that the plants were injured in fumigating the greenhouse in which the test is being conducted.

The carnation experiment has produced interesting results during the past year. The minimum number of plants in any one variety plot in the carnation experiment was "thirteen," and in the majority of the plots there was a standard number of twenty-one plants. The data in the table below show the comparative response of the different varieties included in this test.

TABLE V—YIELD, PERCENTAGE WEAK STEMS AND SPLITS OF CARNATIONS IN GREENHOUSE TEST

	Average Yield per Plant					Percentage Splits	Percentage Weak Stems
	Grade 1	Grade 2	Grade 3	Grade 4	Total		
White Matchless.....	8.6	2.1	1.3	.4	12.4	0.4	4.9
Hilda.....	7.1	2.3	1.7	1.1	12.2	2.0	0.4
Harvester.....	7.8	2.0	1.8	.4	12.0	0.0	4.0
Spicy White.....	5.2	2.6	2.4	1.3	11.5	2.1	2.1
Senator.....	9.5	1.1	.5	.1	11.2	4.7	3.4
Spectrum.....	9.3	.7	.6	.2	10.8	13.5	2.6
Ivory.....	8.2	1.2	.9	.1	10.4	2.3	0.9
Early Dawn.....	8.4	1.4	.3	.2	10.3	13.0	4.6
Potentate.....	6.5	2.6	1.0	.1	10.2	12.3	0.8
Sunglow.....	5.2	2.3	1.6	.9	10.0	5.3	20.1
Betty Lou.....	5.8	1.7	1.2	.2	8.9	11.2	1.2
Radiolite.....	8.1	.3	.1	....	8.5	1.7	0.0
P. Abundance.....	4.7	2.4	1.1	.2	8.4	2.6	0.0
Jones.....	6.3	.8	.7	.2	8.0	17.8	0.6
Gore.....	5.0	1.0	1.0	1.0	8.0	9.5	1.2
Salmon Spectrum.....	6.6	.4	.6	.3	7.9	8.0	7.0
Red Matchless.....	5.8	.9	.6	.2	7.5	11.9	0.7
Ward.....	6.0	1.0	....	.2	7.2	15.3	0.0
Laddie.....	5.8	.8	.4	.1	7.1	17.9	0.0
Fairy Queen.....	4.5	.5	.4	....	5.4	0.0	4.4
Maine Sunshine.....	2.1	.8	.5	....	3.4	10.9	9.0

\*Grade 1 Stem 18" up.  
Grade 2 Stem 15"-18".

Grade 3 Stem 12"-15".  
Grade 4 up to 12".



**Microchemical Studies of Rose Cuttings.**—G. O. RANDALL and J. G. WEAVER. It is a generally recognized fact that there is a wide variation among different varieties of roses and the ease with which they may be rooted from cuttings when the common procedure is followed. For example, in the case of the varieties Talisman and Briarcliff, the difference has been found to be as great as 50 percent, the latter variety being the easiest to root. This difference is shown quite conclusively in the following table:

NUMBER AND PERCENTAGE OF ROOTED CUTTINGS

Variety	Number Rooted	Number Not Rooted	Percentage Rooted
Lot 1—Briarcliff .....	46	53	46.7
Talisman .....	1	84	1.2
Lot 2—Briarcliff .....	60	47	56.1
Talisman .....	8	93	7.9

With these facts in mind a study was made of the microchemical differences in cuttings of Talisman and Briarcliff varieties of rose during the period from the time the cuttings were placed in the propagation bench until roots formed.

The results show:

1. Briarcliff and Talisman varieties of rose have a high starch content in the tissue of stems commonly used for cuttings. The starch is most concentrated in the medullary rays, but is also found more sparsely distributed in the pith and all cortex tissue.
2. Both varieties show a high sugar content throughout the stem tissue.
3. As callous tissue begins to form the starch disappears in the tissue just above or in the immediate vicinity of the callous.
4. The sugar content in the callous tissue is greater than in the other stem tissue.
5. Both varieties have nitrates quite uniformly distributed in the phloem tissue. Talisman, in addition, has nitrate in the pith tissue.
6. Lack of root formation in cuttings of the Talisman rose, under the conditions of the experiment, was not due to the absence of an abundant supply of starch.

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## RESEARCH IN ZOOLOGY AND ENTOMOLOGY

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The research in the Department of Zoology and Entomology is centered around the study of insects and other animals of economic importance and around the taxonomy of certain insect groups. In general, the work on taxonomy is carried on by members of the teaching staff who have no regular time for research but use odd hours during the week for this work. Taxonomic work lends itself to such irregular hours because it can be laid aside at any time. Economic studies cannot be pursued at odd hours, as this work requires careful and detailed attention at specified times.

The economic studies have been concerned with the corn ear worm, the harlequin bug and the bean leaf hopper, the wintering of bees and a survey of the honey plants of the State.

**Project No. 1.—Biology of the Homoptera.**—Z. P. METCALF, *Leader*. The object of the project was to determine the effects of leaf-hoppers on various plants. Two species of hoppers were used in the experiments, *Empoasca fabae* and *Erythroneura obliqua*. The plants used were cotton, Ootootan soybeans, peanuts, bush beans, butterbeans, clay peas, and whippoorwill peas.

The plants were grown in small vials containing absorbent cotton. The cotton was kept moist with a nutrient solution so that the plants remained in a growing condition. The plants were covered with an ordinary lantern globe.

In the experiments with cotton from one to as many as six *Empoasca fabae* were put on a single plant. The first indication of hopper damage was the wilting of the plant. The leaves were usually whitish mottled in appearance. This was followed by a curling and drying of the leaf tips and usually the entire plant died within a few days. When a number of hoppers were put on a plant the damage could be noticed within three or four days. The check plants remained in a healthy condition.

When as many as six *Empoasca fabae* were placed on Ootootan soybeans the plants began to wilt within one or two days. The tender tips of the plants usually died first, and then the lower parts of the plant.

Experiments with *Empoasca fabae* on whippoorwill peas indicate that hoppers in sufficient numbers may entirely kill a plant. When six hoppers were placed on plants they showed signs of damage in two to four days. The leaves wilted and this was followed by a curling and drying of the tips. The entire plant usually died. Check plants remained in good condition.

Experiments with *Empoasca fabae* on peanuts show that hoppers may cause severe damage to the plants, and if in sufficient numbers may cause the plant to die. Hopper damage on peanuts causes the leaves to become whitish mottled in appearance. The leaves wilted, their tips turned brown, dried out and curled. The checks were in healthy growing condition and showed no such damage.

A series of experiments were conducted with *Erythroneura obliqua* on Ootootan soybeans, clay peas, butterbeans, and bush beans. This species of hopper fed on the plants but very little. They could usually be seen crawling about on the lantern globe and all of them were dead within seven days. The

plants did not show any ill effects as a result of the hoppers being placed on them.

**Project No. 3.—The Corn Root Worm.**—Z. P. METCALF, *Leader*. (The Morphology of the Genus *Diabrotica*, George Horton.) The morphology of the Southern Corn Root Worm (*Diabrotica duodecempunctata*), the Striped Cucumber Beetle (*Diabrotica vittata*), and the Northern Corn Root Worm (*Diabrotica longicornis*), has been studied. Many specimens have been dissected and careful studies have been made of the head, antennae, mouth-parts, the sclerites of the thorax, the sclerites of the abdomen, and the genitalia of each species. From these studies a total of about 90 drawings have been carefully prepared showing the various aspects of the parts.

**Project No. 4.—Corn Earworm.**—B. B. FULTON, *Leader*. During the summer of 1931 the infestation of earworms as indicated by weekly counts of eggs on fresh silks, reached 100 percent during the second week of August. This corresponds closely to the record for the previous summer. The peak in average number of eggs per ear (24.7) was reached August 24, as against August 19, for the previous summer. The number of eggs per ear tends to rise with a reduction in the number of fresh silks available in the immediate locality, but during both years the general average for July has been much lower than for August. The greatest number of eggs found on one mass of silks was 110.

*Emergence of Earworm Moths from Overwintering Pupae.* No moths emerged from overwintering pupae from cages in clay soil where worms entered August 4 or earlier, and none from cages in fine sandy loam where worms entered August 18 or earlier.

Total emergence from lots of worms entering soil near the same date was larger in clay soil than in fine sandy loam except for those entering the first week of September 1930, in which case there was slightly greater total emergence from sandy loam.

In clay soil the emergence from overwintering pupae was greatest (27.9 percent of total) from worms entering the ground September 16 to 20, 1930. Emergence from this lot during the fall of 1930 was only 6.7 percent. Worms entering clay soil September 30 to October 12, 1930, produced no moths during the fall, and only 4.8 percent during 1931. The cage containing worms entering August 19 to 23, 1930, gave an emergence of 17.5 percent in 1930, and 15.9 percent in 1931. The next lot which entered September 2 to 8, 1930, gave 20.3 percent in 1930, and only 2.7 percent in 1931.

In fine sandy loam the highest emergence from overwintering pupae was from worms entering October 1 to 15, (9.8 percent). The next highest was from worms entering September 3 to 7, (4.4 percent).

From the results it would appear that a field of corn in which the grain had begun to harden before the middle of August, 1930, would not have been an important factor in starting infestation of earworms the following year.

Emergence of moths during 1931 from worms entering the clay soil the same year was as follows:

Period	July	Aug.	Aug.	Sept.	Sept.	Oct.
(Worms entering ground) .....	15 to 24	3 to 5	16 to 21	4 to 8	17 to 26	1 to 12
Percent of total emerged .....	47.9	37.5	56.7	9.3	17.0	7.7

In two cages the soil was broken up to a depth of six inches but not turned over, and the top 2 inches thoroughly pulverized. In one, with worms entering July 25 to 26, the fall moth emergence was 4.7 percent. Lots entering immediately before and after this period, but not disturbed, gave emergence of 47.9 percent and 54.2 percent, respectively. The other cage with worms entering August 25 to 29 gave fall emergence of 1 percent against a check lot (August 21 to 25) giving 34.3 percent.

Further efforts were made to find some means of preventing earworm infestation of roasting ears. In this work field corn was used in many cases for preliminary experiments and methods showing possible value were later tested on sweet corn. Treated ears were labeled with tree tags with condition of silk (dry, drying, full or young) at time of treatment marked on the tag. Ears were examined when they reached roasting ear stage and the infestation and effect of treatment recorded. The following materials were applied to silks or injected into mass of silks at tip of husk:

- Emulsion—mineral oil and black pepper oil.
- Emulsion—mineral oil and lemon oil.
- Soap solutions, several strengths and kinds.
- Derrisol—in water and in mineral oil emulsion.
- Pyrethrol—in water and in mineral oil emulsion.
- Mineral oil emulsion.
- Mineral oil emulsion with pyridine.
- Tree tanglefoot—applied after clipping silks.
- Resin and cottonseed oil.
- Tanglefoot diluted with turpeneol.
- Soap solution with lead arsenate.
- Soap solution with barium fluosilicate.
- Black Pepper oil—undiluted.
- Lemon oil—undiluted.
- Sassafras oil—undiluted.
- Palm oil—undiluted.
- Corn oil—undiluted.
- Mustard oil—undiluted.
- Castor oil—undiluted.
- Calmosul 20—(Calcium sulphite, lime and magnesium arsenate).
- Rubbed on silks by hand.
- Lead arsenate—rubbed on silks by hand.
- Black Pepper oil—2 percent emulsion, injected.
- Mustard oil—2 percent emulsion, injected.
- Electricians tape, bound around tip of husk.
- Cheese cloth strips, tied around tip of husk.
- Soft pasteboard bands tied around tip of husk.
- Same impregnated with pyridine 5 percent in mineral oil.
- Same impregnated with lemon oil.



Same impregnated with pepper oil.

Same impregnated with cedar oil.

Ethylene dichloride 3 parts, carbon tetrachloride 1 part. Small amount injected.

Carbon disulphide, small amount injected.

Most of the treatments proved of no value because of injuries to the ear or because they imparted an unpleasant flavor. Poisons applied to the silk or injected in suspension into the mass of silks in the tip of the husks gave only slight control with one treatment. Bands of various kinds on the tip of husk gave partial control on field corn by confining the worms to the mass of silk for a longer period. Impregnation of the bands with various materials did not seem to add any improvement. When applied to sweet corn such mechanical means proved much less effective, and many worms entered through the sides of the husk. The use of small amounts of volatile fumigants injected into the tips of ears with dry or drying silks caused only slight injuries to the ears and gave good control on field corn. When tested on sweet corn only, partial control (25 to 30 percent) was obtained. These differences are probably explained by the looser character of the husk on sweet corn. The last mentioned tests were made only after the middle of August when conditions of maximum infestation prevailed.

**Project No. 6.—Wintering of Bees.**—F. B. MEACHAM, *Leader*. Interest in this subject has been sufficient to warrant its continuance. The plan of the project has been the same for the past several years. Comparative results on the different methods of wintering bees are based on the number of bees in a colony, the amount of developing young, and the food consumed.

Data for the last season (the winter of 1930-31) have not been completely assembled, but due to the uniform type of winter some interesting facts will probably be shown.

Last fall twelve representative colonies were used for the experiment and observations made on the whole apiary. The winter period was regularly or uniformly cool, which condition was considered conducive to good wintering of bees. Our winter problem proves to be one of changing temperatures rather than extremely cold ones.

From this data it seems that even during such a good winter for bees, added protection has advantages, for bees wintered in the double-walled hives built up more quickly and stored more honey than those wintered by other methods. The case packing method did not give such good results as it did in previous years. Colonies with around 4,800 to 6,000 bees wintered but did not produce any surplus honey the following season. From small queenless colonies it was found that the winter death rate was 3,000 bees. A mere handful of 1,800 old bees at the close of winter could care for a set of combs, but these were soon united with stronger colonies.

**Project No. 7.—A Survey of the Honey Producing Plants of the State.**—F. B. MEACHAM, *Leader*. Some new records were added to our data last season, and interesting information was secured from the Piedmont section of the State. An accurate account of the honey plants with their blooming dates was secured and these names and dates were correlated with records secured by placing a representative colony on a set of scales. Changes in the weight of this colony were kept each day during the honey

season. In this case the greatest gain was recorded between May 5 and May 20, at which time crimson clover, privet hedge, white clover, and alsike clover were in full bloom. Tulip poplar was in full bloom, or completed blooming during this period. These plants, with probably the exception of the privet, are credited with furnishing the major portion of our surplus honey.

From the records, the blooming dates of the early honey plants will vary with the character of the spring, while the later plants bloom with greater uniformity of dates from year to year. From all reports of the plants in the eastern section, forty-five nectar producing plants are listed. Also it was found that such information should be of much help to the beekeeper as these plants are important surplus honey yielders. Huckleberry blooms April 6, and lasts for thirty days; Tupelo gum blooms April 20, and lasts for 30 days; gallberry, May 12, and lasts 28 days; and holly April 24, and lasts for 16 days.

**Project No. 8.—The Bees of North Carolina.**—T. B. MITCHELL, *Leader*. Additional data regarding the occurrence of bee species in the State have been obtained during the past year, but no change has been affected in the status of the project, as it is by nature a long-time project in which the data are accumulated gradually and as opportunity offers. Identification of many of the species that occur within the State is very difficult, and is to a considerable degree dependent upon specialists in certain restricted groups of species or upon their publications. Several of the large and important groups of bees have been neglected so far as any efforts toward their revision are concerned. Two families especially, the Andrenidae and Anthrophoridae, are in need of such revision, as their species are very numerous, with many of them probably unnamed as yet, and many of them of considerable importance as pollinating agents of fruits and flowers.

**Project No. 20.—The Taxonomy and Biology of the Leaf-cutter Bees.**—T. B. MITCHELL, *Leader*. The manuscript of the revision of this group of bees (Genus *Megachile*) occurring in North America is nearly completed, and should, therefore, be ready for publication in the near future. In this revision sixteen subgenera are recognized as occurring in North America north of the Mexican border, ten of these subgenera being described as new. Approximately 116 species are included, many of them new to science, and one or more geographical races or varieties are described for many of the more widely distributed species.

**Project No. 24.—Harlequin Bug.**—B. B. FULTON, *Leader*. Some additional tests of contact insecticides on the harlequin bug were made. Commercial potassium oleate was tried with and without free nicotine. At a strength of 2 percent by weight of commercial product, used in a room in still air, the potassium oleate with or without nicotine killed all the bugs, proving to be about as effective as many other soaps previously used. At 1 percent strength there was a slightly improved kill by the addition of free nicotine, 1 part actual nicotine to 4,800 parts of solution, but this was not as effective as the soap alone at 2 percent. Free nicotine, or nicotine sulphate, actual content of 1 part in 1,000 parts of  $\frac{1}{2}$  percent potassium oleate solution were no more effective than  $\frac{1}{2}$  percent potassium oleate alone which killed none of the bugs under the condi-

tions of atmospheric evaporation during the comparative test. Penetrol, a commercial nicotine activator, combined with free nicotine or nicotine sulphate (1 part in 1,000) was not effective. Penethrum and Nicotrol, a commercial combination of penetrol with pyrethrum and nicotine, gave only a small percentage of kill at 1 part to 100, and 1 part to 50.

Some tests were also made from soaps prepared from fatty acid and alkalis, namely, the stearates, palmitates, and oleates of sodium and potassium. At 1 percent and 2 percent actual soap content they showed differences in killing efficiency, but none proved as effective as a solution of a commercial soap (2 percent without allowing for water content) used for comparison. Using mixtures of two of the above soaps in equal parts in all possible combinations at 1 percent showed no noticeable improvement in kill.

**Project No. 26.—The Genetics of *Habrobracon*.—C. H. BOSTIAN, Leader.** The continuation of a selection line has indicated that the tendency for the production of diploid males (reproduction from sterilized eggs) in *Habrobracon* is hereditary, since the proportion was increased by selection. Since the twentieth generation, however, no increase has been made, an indication that the strain is pure for whatever hereditary factors there are which regulate the production of diploid males.

A study of various conditions which might cause the proportion of these males, when they occur, to fluctuate has yielded the following conclusions:

1. Unrelated stocks produce no such males, and as stocks become more and more related by inbreeding the proportion is gradually increased, up to certain limits.

2. Sex has very little influence on regulating the ratio, since reciprocal crosses have given practically the same ratios.

3. The age of the mother or of the sperms, or both, has very little effect on the ratio, although as any female grows older after having begun to lay eggs, the proportion of diploid males among her biparental offspring decreases.

New mutations occurring within the year have been tested for linkage with other factors, and some progress is being made in determining the linkage relationships of the known genes. About twenty of the mutant forms were on demonstration at the last meeting of the North Carolina Academy of Science.

**Project No. 27.—Parasites of Oriental Fruit Moth.—B. B. FULTON, Leader.** Ten colonies of the parasite, *Macrocentrus ancylovora* were shipped from the U. S. Bureau of Entomology laboratory at Moorestown, N. J., during July and released in peach orchards in the State, as follows: 8 in various parts of the sandhill district; 1 near Raleigh, and 1 near Mount Airy. Each colony contained several hundred individuals. In May a colony of *Macrocentrus* and one of *Glypta rufiscutellaris* were released near Raleigh.

**Project No. 28.—Report on the Biology of *Aphis gossypii*.—H. R. JOHNSTON, Leader.** A study of this species is being made with reference to its life history for this locality. Experiments are being conducted to determine any relationship that may exist between the cotton aphid (*Aphis gossypii*), the corn root aphid, (*Aphis maidi-radidis*), and the corn leaf aphid (*Aphis maidis*).

During the fall of 1931 observations were made in the field to ascertain the date that *Aphis gossypii* left cotton. Observations were started again early in the spring of 1931, with the view of determining when this species reappeared on cotton. Field studies were made during the spring and summer of 1931 in relation to the host plants of this species.

Life history studies of *Aphis gossypii* were started in the insectary on January 22, 1931. Since that date forty-nine complete generations have been reared. On May 18 the plants on which the life history studies were being made were moved to the outside insectary so that conditions would be as nearly normal as possible. Temperature records have been kept since May 18.

Several attempts have been made to rear *Aphis gossypii* in complete darkness. Results of these experiments thus far indicate that this species cannot exist over three generations without light. One colony, however, continued to live for forty-one days. Life history studies were made on this colony.

In studying the relationship of the three species, the following transfers have been made:

- 42 *Aphis maidis* from corn leaf to sprouting corn.
- 3 *Aphis maidis* from corn leaf to sprouting cotton.
- 47 *Aphis maidis* from corn leaf to cotton leaf.
- 80 *Aphis gossypii* from cotton leaf to cotton roots.
- 15 *Aphis gossypii* from cotton leaf to corn roots.
- 16 *Aphis maidi-radialis* from corn roots to sprouting cotton.
- 17 *Aphis maidi-radialis* from corn roots to cotton leaf.
- 6 *Aphis maidi-radialis* from corn roots to corn roots in light.

The results of these transfers indicate the leaf forms and root forms of aphids are distinct species. However, no definite conclusions can be drawn from the limited number of transfers that have been made.

Magnesium sulphate was tested to determine its influence on the production of wings in *Aphis gossypii*. 323 aphids were used in the experiment. The results of the experiment show that magnesium sulphate is not a factor in wing production in this species.

Z. P. METCALF,  
*Entomologist.*



## RESEARCH IN POULTRY

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Disease studies, as embodied in this report, are investigations of those diseases which are prevalent in North Carolina poultry today. While fundamental facts are sought, practical application in the form of control measures is likewise borne in mind, and it is hoped that contributions of value to the progress of the industry will be the result of these investigations.

### AVIAN TYPHOID STUDIES

Work of the past fiscal year has involved confirmatory studies of findings noted in 1929-30 as to duration of immunity produced by vaccination of fowls against avian typhoid. This has been effected by applying the experimental findings, that immunity produced by vaccination against avian typhoid is effective for only about ninety days time, to field practice.

In 39 outbreaks in the past year cooperative action has been entered into with the flock owners. Complete reports on the three vaccinations at 90-day intervals as recommended have been received from twelve out of seventeen cooperators. These twelve reports involve 1,834 birds. Reports from three flock owners who have vaccinated twice have not been received. This group involves 415 birds. The total number of birds involved in these studies is 3,820.

The reports indicate that the investigational findings are finding confirmation under practical conditions in the field and that, under the North Carolina conditions, the birds should receive at least three vaccinations at 90-day intervals in order to maintain immunity when flocks are ranged on land infected with the organism of avian typhoid (*E. sanguinaria*).

Experimental investigation of the duration of soil infection with this disease has brought out certain facts which conflict with the general conception of this problem. These factors are discussed at length in a technical bulletin now being prepared.

Studies as to the tolerance of the fowl to avian typhoid vaccine have been made. These studies were made to determine how large a dose could be administered without serious clinical derangement of the bird. The dosage ranged from 2.0 to 4.0 c.c., using 0.5 c.c. intervals in increasing doses. The value of this determination lies in the fact that experimental findings in this project show that the single vaccination produced relatively the same duration of immunity as the double and triple vaccinations and that the matter of size of dose was of importance as this method was to be recommended in the field. The measuring of results in this work was chiefly that of blood counts and clinical symptoms. Studies conducted gave little indication of any serious upset brought about in the bird, even when the high level (4.0 c.c. per bird) was used. Elevation of temperature of one degree in about six hours after vaccination may be observed in birds receiving from 3.5 to 4.0 c.c., but no definite depression was noted nor tendency toward amphylactic shock observed. As would be expected under such conditions, there is a blood derangement of greater or less severity according to the individual. Such changes are not always consistent, although an eosinophilia was constantly observed

until 24 hours after vaccination. The laboratory findings in the cases studied are contrary to field observations in which a distinct depression following vaccination is often observed with egg production falling off for a period of about seven days. Full discussion of this study will be presented in bulletin now being prepared.

### **PATHOLOGICAL HEMATOLOGY**

This investigation is of an accumulative character. Sick birds sent in for diagnosis are studied clinically and blood studies made prior to autopsy. The findings are then correlated with the autopsy findings. The aim in this investigation is to seek definite information as to the relationship of blood structure to disease in the fowl. Studies have been recorded during the past year on anemia, tumors, roup, bronchitis, typhoid, and paralysis. Not sufficient data have been accumulated to the present time for publication, large number of studies of all diseases being sought.

### **STUDIES OF INTERMITTENT REACTORS**

Due to a difference of scientific opinion as to whether or not serums from reactors were sensitive to one antigen and not sensitive to others and that this fact might be entering into the phenomenon of intermittency in reaction as encountered in field testing, this phase of pullorum disease work was investigated during the past year.

Eleven monovalent and four polyvalent antigens were prepared, these consisting of three cultures selected by the Pullorum Disease Conference for their excellent qualities for agglutination work, three strains from the laboratory of Dr. L. F. Rettger, Yale University, three strains used during the past five years in the investigational work in North Carolina, and two strains from the Ontario Agricultural College, Canada. The polyvalent antigens were combinations of the above groups as noted. Two hundred and sixty-three blood serums were run against these antigens. These serums were from birds of proven "borden line" reaction, or those birds presenting light reactions, intermittent in character. Dilutions run were 1:10 and 1:25. Pooled serum of the reactors under study were run against these antigens for further data. The tube method of test was employed and the technic was that of the North Carolina Poultry Disease Research Laboratory as noted in Technical Bulletins No. 29, and No. 36, of the North Carolina Station. None of these serums gave a past history of reacting consistently in a clear cut manner in a dilution of 1:50.

While some of these serums exhibited a slight preferential sensitivity in occasional instances, there was shown no consistent trend in any one direction which would indicate that the using of more than one antigen in routine work of testing would be advisable. These results confirm field findings that intermittency of reaction is not brought about by the lack of a specific antigen as intermittent reactors in the field are detected as positive on the same antigen, after having proven negative on a past test on the same antigen.

These tests likewise indicated that a dilution as low as 1:10 should not be used in routine work.

A cooperative study was made of the use of the whole blood, rapid method of testing for pullorum disease. This was undertaken at the

request of Dr. Dorset, Bureau of Animal Industry, Washington, D. C. One hundred and fifty-two bloods, mainly from light reactors, were tested, the results indicating that this new method of testing shows promising results.

Investigations as to serum titer trends of reactors have been continued during the past year. This work has been going on for four years. One flock has been tested semi-monthly for about four years, one for three years, and one for two years. These latter two flocks are progeny of the initial birds. The work of the past year confirms the studies published in Technical Bulletin No. 36 in that the serum titer fluctuations continued as noted. Egg analysis bears out the data previously submitted. With the exception of one case, the intermittent reactors have remained intermittent reactors, and those reacting constantly positive have maintained that tendency. The fluctuations of serum titer remain as previously reported.

Analysis of the results of the second year's testing at short intervals as carried out by the State Department of Agriculture shows the following results: 98 or 25.3 percent of 387 flocks tested were negative on the application of the first test in comparison with the 15.7 percent of the flocks showing the same condition on the application of the first test in 1929-30. As these flocks on the whole were built up from the output of the North Carolina hatcheries, it is felt that the system of testing as practiced in North Carolina, is showing results. Of 114 flocks accredited in 1930, 62 or 54 percent proved free on the initial tests in 1930-31 testing season. Of flocks showing absolutely no infection on the first two tests in 1929-30 seven showed infection in 1930-31, and in these flocks only the eggs from the flocks themselves were hatched and used for replacement stock. In accredited flocks of last year, from which reliable information could be secured and in which replacement stock was obtained from North Carolina blood-tested hatcheries or from eggs from their own flocks, 20 showed negative initial tests, 19 were positive on initial test and showed less initial infection than in the past season, and 14 were positive on initial test but showed greater initial infection than in 1930.

Of accredited stock, in which was introduced blood from untested sources in 1931, we found one flock positive in 1931 that was negative in 1930; one flock that was negative in both 1930 and 1931. In unaccredited flocks in 1930, three were positive in 1931 but showed less initial infection, and five similar to the above showing greater initial infection.

From the above and other data, it is apparent that there are transmitting factors of this disease that are not yet understood and which are active at all times.

A very interesting check was obtained on the work of last year in regard to the percent of intermittent reactors found under field conditions.

In 1929-30 a total of 1,859, or 36.8 percent of 5,053 birds reacting in 37,893 tested were detected on tests subsequent to the initial one, while in 1930-31, 2,169, or 30.9 percent of 7,028 reactors were found in 63,899 birds tested were intermittent in type of reaction. The tests in 1930-31 were not carried as far as in 1929-30, which probably accounts for the lower figure. Combining the totals of the two years work, there are found 12,081 reactors in 101,792 birds, and of these reactors 4,028, or 33.3 percent were not detected on the first test as these reacted intermittently.

### GROWTH RATES OF CHICKS RECEIVING COD LIVER OIL AND NO SUNLIGHT AS COMPARED WITH THOSE RECEIVING SUNLIGHT AND NO COD LIVER OIL

This project consists in measuring the effects of cod liver oil for the first twelve weeks of the chick's life as compared with no cod liver oil but having access to sunlight. The chicks included in this test were divided into two lots containing sixty-one Single Comb Rhode Island Reds, sixty-two Barred Plymouth Rocks, and sixty-one Single Comb White Leghorns. These chicks were hatched May 16 and were pedigreed, being evenly divided, as far as ancestry was concerned, between the two pens. This division of pedigreed stock was carried out in order to equalize as far as possible any inherited tendencies toward rapid development. These birds were housed in 10x12 brooder houses and the chicks in Lot 1, receiving cod liver oil, were left confined without sunlight for the duration of the test; while the chicks in Lot 2, having no cod liver oil in the ration, were allowed access to a sun porch at all times. The following mash ration was fed the birds:

- 30 lbs. yellow corn meal.
- 20 lbs. wheat middlings
- 15 lbs. heavy oats (finely pulverized)
- 12 lbs. wheat bran
- 7 lbs. vacuum dried fish meal (55% protein)
- 7 lbs. meat scrap (55% protein)
- 5 lbs. dried buttermilk
- 4 lbs. steamed bone meal
- $\frac{1}{2}$  lb. iodized table salt.

The scratch ration was as follows:

- 40 lbs. yellow cracked corn
- 40 lbs. cracked wheat
- 20 lbs. pinhead oats.

For the chicks in Lot 1, as noted, one percent biologically tested cod liver oil, was incorporated in the mash. The mash was left before the birds at all times and results are shown in the following tables.

#### Discussion of Table

Results show that in this experiment a greater growth rate was obtained with the birds fed cod liver oil mash without access to sunlight than those fed mash without cod liver oil but having access to sunlight. The chicks in Lot 1 showed a constantly higher mash consumption than those in Lot 2, and while the grain consumption for Lot 1 was higher per bird for the first six weeks, this was reversed for the latter period of the test.

The mortality in the cod liver oil pen was 9.8 percent as compared with 27.1 percent in the pen not given cod liver oil. No practical method could be devised to measure the utilization of the sun porch by the birds in Lot 2, but observations indicate that this was utilized for practically the same length of time as birds of a similar age in an adjacent pen utilized free range.

While variations in numbers of sex from individual birds were encountered in the two pens, it was noted that eleven Red cockerels from the same sire and dam in Pen 1 averaged 2.16 pounds as compared with 2.00 pounds in eleven cockerels of similar ancestry in Pen 2, while eleven



COD LIVER OIL vs. No Cod Liver Experiments

WEEK	BARRED PLYMOUTH ROCKS				S. C. RHODE ISLAND REDS				S. C. WHITE LEGHORNS				FEED PER BIRD			
	C. L. O.		NOC L. O.		C. L. O.		NOC L. O.		C. L. O.		NOC L. O.		C. L. O.		NOC L. O.	
	No. Birds	Weight Per Bird	No. Birds	Weight Per Bird	No. Birds	Weight Per Bird	No. Birds	Weight Per Bird	No. Birds	Weight Per Bird	No. Birds	Weight Per Bird	Mash	Grain	Mash	Grain
Inc.		.09		.08		.09		.09		.08		.08				
1	61	.11	62	.11	61	.12	61	.12	61	.12	59	.12	0.12		0.09	
2	59	.17	62	.18	59	.19	61	.18	61	.19	59	.19	0.32		0.25	
3	59	.24	62	.26	59	.30	61	.30	61	.29	59	.26	0.34	.06	0.29	.06
4	59	.34	62	.33	59	.41	60	.37	61	.36	54	.34	0.37	.18	0.22	.22
5	58	.44	61	.41	58	.52	58	.46	58	.47	51	.41	0.52	.03	0.39	.06
6	58	.56	57	.51	58	.68	53	.56	58	.58	44	.49	0.63	.16	0.31	.17
7	58	.69	55	.64	57	.84	45	.80	55	.73	32	.60	0.71	.23	0.46	.29
8	56	.87	54	.79	57	1.01	44	.93	53	.88	32	.74	0.77	.36	0.47	.22
9	56	1.03	54	.96	57	1.27	44	1.08	53	1.06	32	.93	0.84	.39	0.49	.24
10	56	1.16	54	1.09	57	1.45	44	1.25	53	1.22	32	1.06	0.89	.30	0.53	.28
11	56	1.32	54	1.24	57	1.66	44	1.45	53	1.39	32	1.21	0.91	.36	0.57	.34
12	56	1.53	54	1.42	57	1.89	44	1.62	53	1.58	32	1.38	0.96	.38	0.61	.41

pullets of the Reds in Lot 1 averaged 2.00 pounds as compared with an average weight of 1.71 for eleven pullets from similar sires and dams in Pen 2. Among the Leghorns three cockerels in Pen 1 weighed 1.07 pounds as compared with 1.47 pounds average of three cockerels of similar parents in Pen 2, while twelve Leghorn pullets in Lot 1 weighed 1.66 pounds as compared with 1.50 pounds of twelve Leghorn pullets of the same sire and dam in Lot 2. In the Rocks four cockerels in Lot 1 averaged 1.90 pounds as compared with 1.73 pounds of four of their brothers in Pen 2 and eighteen pullets averaged 1.69 pounds as compared with 1.59 pounds for eighteen pullets of similar ancestry in Pen 2.

### CLASSIFICATION OF CAUSES OF POULTRY MORTALITY

As an index to the prevalence of contagious diseases of poultry and as to pathological cause of death in birds succumbing from causes not of germ-borne origin, the following classification is made of 1,269 birds submitted to the Poultry Disease Laboratory from that number of poultry farms in North Carolina from September 1, 1930, to September 1, 1931.

#### CLASSIFICATION OF CAUSES OF POULTRY MORTALITY IN NORTH CAROLINA

DISEASE GROUPINGS	ADULTS		RANGE STOCK		CHICKS		Grand Total	Percent
	Total	Percent	Total	Percent	Total	Percent		
Diseases and Disorders of the Digestive Tract.....	46	6.3	26	13.6	8	2.3	80	6.3
Diseases of the Glandular Organs.....	16	2.2	1	0.5	3	0.9	20	1.6
Nervous Disorders.....	9	1.2	6	3.1	-----	-----	15	1.2
Respiratory Disorders.....	119	16.3	9	4.7	13	3.7	141	11.1
Septicemic Diseases.....	61	8.4	6	3.1	185	52.6	252	19.8
Uro-genital Tract Disorders.....	43	5.9	2	1.0	1	0.3	46	3.6
Neoplasms.....	63	8.7	7	3.7	3	0.9	73	5.7
Nutritional Disorders.....	9	1.2	3	1.6	12	3.4	24	1.9
Abdominal Disorders.....	16	2.2	-----	-----	2	0.6	18	1.4
Circulatory Disorders.....	32	4.4	-----	-----	-----	-----	32	2.5
Ocular Disorders.....	1	0.1	-----	-----	-----	-----	1	0.1
Protozoan Diseases.....	48	6.6	43	22.6	43	12.2	134	10.6
Constitutional Diseases.....	34	4.7	-----	-----	10	2.8	44	3.5
Internal Parasites.....	100	13.7	61	32.1	14	3.9	175	13.8
Unknown.....	79	10.8	15	7.9	49	13.9	143	11.3
Miscellaneous.....	51	7.0	11	5.8	9	2.5	71	5.6
	727	99.7	190	99.7	352	100.0	1,269	100.0

### GRAZING CROP EXPERIMENTS

This project was carried on in cooperation with the Department of Agronomy. Prior to experimental work the land had been in sod for six years, was acid in reaction and of poor texture. The object of the experiment was to test the adaptability of the soil to a wide variety of grazing crops thought suitable for poultry, to measure the duration of grazing periods furnished by each crop or mixtures of crops, and the relative degree that poultry would utilize such crops.

Soil tests showed the acidity to be approximately pH 5.3, necessitating the use of 3,000 pounds of lime to the acre and 600 pounds of a 10-4-4 fertilizer mixture.



Showing barren conditions of range of commercial Pen 12. The soil was of poor texture (description) showing an acidity of approximately pH 5.3. Little or no succulent feed could be obtained by poultry grazing on this land.

The work was divided into two phases: that of developing a system of triple ranges for large commercial flocks and a study of spring crops for ranging chicks and developing young stock.

The commercial ranges were limed, fertilized and seeded by September 27, 1930. The results attending these seedings are as follows:

**Pen 11.** Area .863 acres. One range was seeded to alfalfa and rye grass, and two to rye grass alone. Germination occurred in all ranges by October 16. Two hundred birds ranged on rye grass one hour a day from December 1 to January 15, and alternately for full time on all ranges from that date on. The rye grass was green and succulent throughout the winter and the birds showed a distinct preferment for this crop.



Profuse growth was noted during May and June with a tendency to coarseness, the birds not utilizing the rye grass at this time.

Cost of seeding this range was \$9.05; fertilizer, \$12.95; labor, horse and plow, including terracing, \$21.19.

**Pen 12.** Area .728 acres. Seeded in rye grass, rye grass and a mixture of rye grass and crimson clover. Germination occurred October 14-16 and birds were ranged on rye grass range for one hour each day from December 1 to January 15, when they were alternated for full time on other ranges. Green feed was available for practically the entire winter, being furnished principally by the rye grass. Crimson clover made an excellent crop. It was of interest to note that no ill effect was noted by birds grazing this crop when it was going to seed. The clover reseeded itself on being turned under, a luxuriant volunteer crop appearing, this being ranged by the birds into the early summer. Rye grass, however, was much preferred by the birds to the clover. Cost of seed in this plot was \$4.45; fertilizer, \$17.87; labor, including terracing, \$17.87.

**Pen 13.** Area .998 acres. Plot triple ranged and sowed to rye grass, alfalfa and crimson clover. Germination and ranging practice followed as noted in Pens 11 and 12. Some spewing of alfalfa was noted January 15 following a spell of severe weather. The rye grass grange was severely cropped by January 1 by the 200 birds in this pen. The birds when given a choice of three ranges showed preference in the following order—rye grass, clover, and alfalfa. Cost of seeding, \$13.58; fertilizer, \$14.97; labor, \$25.40.

**Pen 14.** Area .789 acres. Triple ranged into rye grass, clover, and alfalfa and clover. Time of seeding, germination and methods of ranging were similar to that noted in Pen 13. As in the case of Pen 13, the rye grass was preferred by the birds over the leguminous crops. In the rye grass range the birds cropped this grass until the ground was apparently bare, but the crop quickly reappeared after the ranges were shifted. Cost of seed, \$10.73; fertilizer, \$11.83; labor, \$19.37.

Observations on these three crops for triple ranging indicate that this selection proved fairly satisfactory, the rye grass proving excellent for late fall and winter grazing and may be rested when the clover is ready for the spring months. Much depends on the alfalfa for the hot weather grazing. An exceptionally severe winter may tend to upset this arrangement but during the past year with the exception of especially severe weather, the birds had access to green feed at all times.

#### PLOT STUDIES FOR CHICK AND DEVELOPING STOCK RANGING

These plots were seeded February 3, 1931, the ground having been previously limed at the rate of 3,000 pounds to the acre and fertilized with a 12-4-4 mixture at the rate of 400 pounds to the acre. The following results were obtained:

**Pen 22.** Area .321 acres, seeded February 3 to rye grass and rape, using 25 pounds rye grass and 8 pounds rape to the acre. Germination occurred in about four weeks time. Ground constantly ranged by 200 to 300 developing birds from March 15 on. Luxuriant growth of both crops during early spring with birds apparently utilizing both crops to





The same range as shown in Photo I after the land had been limed, fertilized thoroughly, worked and terraced. This land was seeded September 27, a fair rain fell October 13 and crops were up on October 16. These ranges developed so that birds could be ranged on them for an hour each day after December 1.



Picture taken May 20. Range seeded to rye grass September 27. Grazed practically all winter until birds were taken from it April 15, at which time it was practically bare. On the date of taking this picture the range was in excellent grazing condition and lasted as such until prolonged hot weather and lack of moisture reduced its value.

advantage. Grazing excellent until June, when rape became coarse and birds utilized only rye grass. Both crops suffered severely during extreme heat and dry weather of summer.

**Pen 23.** Area .321 acres, seeded to rape, lespedeza and white clover. Rape germination in about four weeks, but lespedeza and clover slow. Ground ranged to capacity from March 15 to August 1. Birds showed preference for rape until it got coarse; lespedeza made fair stand but birds apparently preferred rape and white clover. Range furnished ample succulent feed from March 15 until August 1, when birds were removed.

**Pen 24.** Area .28 acres. Seeded February 3 to rye grass, lespedeza and sweet clover. Good stand of rye grass and lespedeza but sweet clover very sparse. Rye grass preferred by birds while succulent. Range furnished abundant feed for period between March 15 and July 1 when birds were removed from range.

**Pen 25.** Area .315 acres. Seeded February 3 to orchard grass, red top, white clover, and sweet clover. Orchard grass germinated readily but poor stand of clovers was obtained. Except during the months of April and May this range furnished little succulent feed and range was probably the poorest of any of the mixtures sowed.

**Pen 26.** Area .270 acres. Limed, fertilized, and seeded by February 3. Rye grass and rape used. Excellent germination and abundant range by March 15. Developing birds ranged plot until June 15 when adults were placed on range. Birds showed little preference, utilizing both crops readily. It is of interest to note that after an extremely hot summer a new crop of rye grass has appeared and should give an excellent stand for autumn grazing.

**Pen 27.** Area .313 acres. Sowed to rye grass alone. Excellent germination and ranging all during spring and into mid-summer. Plot re-seeded itself and should furnish excellent autumn grazing.

**Pen 28.** Area .301 acres. Limed, fertilizer and seeded by February 3 with orchard grass, lespedeza, sweet clover and rape. Slow germination was noted with the exception of the rape. The sweet clover showed very little germination and practically no development. The birds utilized the rape freely, showing a fair appetite for the orchard grass and lespedeza. During the late spring and early summer the lespedeza was ranged in preference to the orchard grass.

**Pen 31.** Area .344 acres. Limed, fertilizer and seeded by February 3. Germination noted by March 1 and birds placed on range latter part of March, at which time abundant grazing crops were present. These crops consisted of orchard grass, red top grass, blue grass, white clover and lespedeza. During the early spring little preference was noted by the birds although the orchard grass was relished in its young stages. The red top grass and blue grass did not make material development. Birds were ranged on this lot until July 15 and made excellent development.

**Pen 32.** Area .384 acres. Limed, fertilized, and seeded by February 3. Rye grass, blue grass, red top grass, sweet clover and alfalfa were used. The grasses outgrew the legumes and apparently were relished by the birds to a much greater degree. On July 1 rye grass was the outstanding crop with very little trace of other growth.



# INFLUENCE OF PROTEIN LEVELS ON DEVELOPMENT OF CHICKS IN BATTERY BROODERS

This project involved the influence of protein level on development of chicks in battery brooder. The battery used was of the oil burner type and the tests were carried for five weeks, check being made on health, development, feed consumption, feed cost of development, and fuel cost. Rhode Island Reds and Barred Plymouth Rocks, equal number of chicks, were used in all tests.

The ration used in this study included the following ingredients: yellow corn meal, wheat middlings, wheat bran, alfalfa leaf and bloom meal, dried buttermilk, meat scrap (55 percent protein), steamed bone meal, biologically tested cod liver oil, and sodium chloride.

In Lot A the total protein ran 16.3 percent and the animal protein 6.3 percent. In Lot B the total protein was 18.3 percent, and the animal protein 8.6 percent. In Lot C the total protein was 20.4 percent, and the animal protein 11.2 percent.

The results of these tests are in the tabulations below.

## TEST NO. I—STARTED JANUARY 17, 1931

### LOT A—16% PROTEIN—INCUBATION WEIGHT OF 36 CHICKS—3.1 POUNDS.

Week	No. Chicks	Weight of Chicks	Gross Gain Per Week	Average Gain per Bird Per Week	Amount Feed Used	Total Cost of Feed	Feed Cost per Pound Gain	Gals. Oil Used	Total Cost of Oil	Cost Oil Per Pound Gain	No. Deaths
1	34	4.2	1.1	.032	3.7	.105	.095	3.80	.464	.422	1 BR 1/19 1 BR 1/23
2	34	6.8	2.6	.076	6.4	.182	.070	1.87	.228	.088	
3	33	10.3	3.5	.106	12.0	.342	.098	1.66	.203	.058	RIR 2/1
4	33	14.3	4.0	.121	12.3	.351	.088	2.00	.244	.061	-----
5	33	17.4	3.1	.094	11.1	.316	.102	1.33	.162	.052	-----

### LOT B—18% PROTEIN—INCUBATION WEIGHT OF 36 CHICKS—3.1 POUNDS.

1	36	4.5	1.4	.039	3.5	.100	.071	3.80	.464	.331	Red 2/4 Red 2/8
2	36	7.1	2.6	.072	6.7	.191	.073	1.87	.228	.088	
3	35	12.0	4.9	.140	11.5	.328	.067	1.66	.203	.041	-----
4	34	16.9	4.9	.144	13.4	.382	.078	2.00	.244	.050	-----
5	34	22.2	5.3	.156	12.7	.362	.068	1.33	.162	.031	-----

### LOT C—20% PROTEIN—INCUBATION WEIGHT OF 36 CHICKS—3.0 POUNDS.

1	34	3.9	0.9	.026	3.8	.108	.120	3.80	.464	.516	BR 1/19 BR 1/23
2	32	5.9	2.0	.063	6.1	.174	.087	1.87	.228	.114	
3	32	10.1	4.2	.131	11.7	.333	.079	1.66	.203	.048	-----
4	32	15.1	5.0	.156	13.6	.388	.078	2.00	.244	.049	-----
5	32	20.2	5.1	.159	11.6	.331	.065	1.33	.162	.032	-----

## TEST NO. II—STARTED JANUARY 26, 1931

## LOT A—16% PROTEIN—INCUBATOR WEIGHT OF 25 CHICKS—1.9 POUNDS.

Week	No. Chicks	Weight of Chicks	Gross Gain Per Week	Average Gain per Bird Per Week	Amount Feed Used	Total Cost of Feed	Feed Cost per Pound Gain	Gals. Oil Used	Total Cost of Oil	Cost Oil Per Pound Gain	No. Deaths
1	24	3.1	1.2	.050	2.9	.083	.069	1.87	.228	.190	1 Red 1/29 1 Red 2/3
2	23	4.7	1.6	.070	5.0	.143	.089	1.66	.203	.127	-----
3	23	6.8	2.1	.091	6.2	.177	.084	2.00	.244	.116	-----
4	23	10.3	3.5	.152	9.9	.282	.081	2.00	.244	.070	-----
5	23	14.5	4.2	.183	16.0	.456	.109	1.35	.166	.040	-----

## LOT B—18% PROTEIN—INCUBATOR WEIGHT OF 25 CHICKS—1.9 POUNDS.

1	21	2.7	0.8	.028	2.7	.077	.096	1.87	.228	.285	2 Reds killed 1/27
2	21	4.3	1.6	.076	5.3	.151	.094	1.66	.203	.127	1 Red 1/28 1 Red 1/29
3	21	7.6	3.3	.157	7.4	.211	.064	2.00	.244	.074	-----
4	21	10.9	3.3	.157	10.6	.302	.092	2.00	.244	.074	-----
5	21	14.9	4.0	.190	13.6	.473	.118	1.35	.166	.042	-----

## LOT C—20% PROTEIN—INCUBATOR WEIGHT OF 25 CHICKS—2.0 POUNDS.

1	24	3.1	1.1	.046	3.3	.094	.083	1.87	.228	.207	1 Red 1/30/31
2	24	4.9	1.8	.075	6.0	.171	.095	1.66	.203	.113	-----
3	24	7.7	2.8	.117	6.3	.180	.034	2.00	.244	.087	-----
4	24	11.0	3.3	.138	11.0	.314	.095	2.00	.244	.074	-----
5	24	15.5	4.5	.188	15.6	.445	.099	1.35	.166	.037	-----



## TEST No. III—STARTED FEBRUARY 2, 1931

## LOT A—16% PROTEIN—INCUBATOR WEIGHT OF 29 CHICKS—2.2 POUNDS.

Week	No. Chicks	Weight of Chicks	Gross Gain Per Week	Average Gain per Bird Per Week	Amount Feed Used	Total Cost of Feed	Feed Cost per Pound Gain	Gals. Oil Used	Total Cost of Oil	Cost Oil Per Pound Gain	No. Deaths
1	28	3.2	1.0	.036	3.9	.111	.111	1.66	.203	.203	1 Red 2/3 1 Red 2/5
2	27	5.4	2.2	.081	4.6	.131	.060	2.00	.244	.111	-----
3	27	8.5	3.1	.115	8.3	.239	.077	2.00	.244	.079	-----
4	27	12.2	3.7	.137	11.2	.319	.086	1.35	.166	.045	-----
5	27	13.9	1.7	.063	4.8	.137	.081	0.87	.106	.062	-----

## LOT B—18% PROTEIN—INCUBATOR WEIGHT OF 29 CHICKS—2.2 POUNDS.

1	25	3.0	0.8	.032	3.7	.105	.131	1.66	.203	.254	1 Red 2/5 2 Reds 2/5
2	23	5.2	2.2	.096	3.7	.105	.048	2.00	.244	.111	1 Red 2/6 1 Red 2/8
3	23	8.2	3.0	.130	7.8	.222	.074	2.00	.244	.081	1 B P R 2/15
4	23	11.7	3.5	.152	11.0	.314	.090	1.35	.166	.047	-----
5	23	13.5	1.8	.078	4.0	.114	.063	0.87	.106	.059	-----

## LOT C—20% PROTEIN—INCUBATOR WEIGHT OF 29 CHICKS—2.2 POUNDS.

1	24	2.8	0.6	.025	3.5	.100	.167	1.66	.203	.338	2 Reds 2/3 1 Red 2/5 2 Reds 2/6
2	24	4.9	2.1	.088	4.1	.117	.056	2.00	.244	.116	-----
3	24	7.9	3.0	.125	8.3	.237	.079	2.00	.244	.081	-----
4	24	11.7	4.2	.175	11.2	.319	.076	1.35	.166	.040	-----
5	24	13.5	1.8	.075	4.5	.128	.071	0.87	.106	.059	-----

These tests indicate that the groups fed the twenty percent protein level showed the greatest gain in body weight at the end of the fifth week.

Study of the cost of feed per pound weight gained indicates that while the low protein level group made the most economical gains during the first two weeks of the test, during the latter three weeks, the feed cost per pound gain showed the twenty percent ration to be the most economical and the sixteen percent ration the most costly. A margin of nearly two cents feed cost per pound gain existed at the end of the fifth week between the sixteen percent and the twenty percent ration indicating that in the type of battery used in these tests, the higher protein level is the more economical ration to use.

The same tendency as noted above existed in fuel cost per pound gain.

Mortality figures did not indicate that the ration was exerting a marked influence on the vitality of the birds during these tests.

#### **COMPARISON OF FEEDING FISH MEAL AGAINST MEAT MEAL AS SINGLE SOURCES OF ANIMAL PROTEIN TO LAYING FLOCKS**

This study involved the feeding of two commercial flocks of Rhode Island Reds a basal ration consisting of 35 pounds of corn meal, 20 pounds wheat middlings, 20 pounds pulverized oats, 4 pounds bone meal, and one pound sodium chloride. To this ration was added 20 pounds of fifty-five percent meat scrap for the meat meal flock, and 20 pounds of machine dried fish meal to the fish meal flock. The birds were as evenly divided as possible as to productive capacity. Mash was kept in the hoppers before the birds at all times, and one pint of grain mixture, consisting of 50 pounds corn, 30 pounds heavy oats, and 20 pounds wheat, was fed to each twelve birds in the evening.

The results of this experiment are tabulated on page 127.

#### **Discussion of Results**

In this study with the exception of May, June and August the fish meal flock maintained a higher percent lay than the meat meal flock. This flock consumed more mash during each month and less grain with the exception of June and July and while feed cost to produce a dozen eggs averaged slightly higher, the higher percent production warranted the extra feed cost. The death rate in the meat meal lot was higher, due to bronchitis in December, but aside from this outbreak, mortality was about equal.

MEAT SCRAP vs. FISH MEAL IN THE POULTRY RATION

	OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST	
	Meat	Fish	Meat	Fish	Meat	Fish	Meat	Fish	Meat	Fish	Meat	Fish	Meat	Fish	Meat	Fish	Meat	Fish	Meat	Fish	Meat	Fish
Number Birds.....	149	150	146	148	123	144	115	142	113	141	111	143	109	138	65	116	63	112	56	101	42	63
Percent Laying.....	8.3	13.0	6.7	11.5	6.8	20.0	31.4	34.8	54.9	59.7	60.6	62.4	54.6	57.0	53.6	50.9	44.5	38.9	29.5	31.2	29.2	27.4
Amount of Mash Consumed.....	418	442	344	532	221	617	376	779	338	708	387	682	303	679	157	416	162	352	101	209	173	295
Amount of Mash Per Bird.....	2.8	2.9	2.3	3.5	1.7	4.2	3.2	5.4	3.0	5.0	3.4	4.7	2.7	4.9	2.4	3.5	2.5	3.1	1.8	2.0	4.1	4.6
Cost of Mash Consumed.....	10.78	11.18	8.91	13.46	5.53	15.42	9.40	19.48	7.50	16.00	8.36	15.28	6.39	14.94	5.50	9.57	3.48	8.10	2.18	4.80	3.34	5.68
Amount of Grain Consumed.....	403	526	487	533	564	481	592	681	535	470	492	537	460	576	337	534	137	383	140	330	230	296
Amount of Grain Per Bird.....	2.7	3.5	3.3	3.6	4.5	3.3	5.1	4.7	4.7	3.3	4.4	3.7	4.2	4.1	5.1	4.6	2.1	3.4	2.5	3.2	5.4	4.6
Cost of Grain Consumed.....	8.66	11.30	10.47	11.46	11.28	9.62	11.84	13.62	10.16	8.93	8.86	9.67	7.68	9.62	6.33	8.97	2.52	6.32	2.41	5.35	3.31	4.26
Pounds Feed to Produce Dozen Eggs.....	26.4	19.0	32.0	25.0	35.6	14.0	10.2	11.3	6.0	5.8	5.0	5.2	5.1	6.3	6.0	6.2	4.2	6.7	5.4	6.4	12.5	13.4
Cost of Feed to Produce Dozen Eggs.....	0.63	0.445	0.74	0.585	0.76	0.329	0.233	0.258	0.125	0.128	0.098	0.108	0.096	0.127	0.155	0.134	0.081	0.131	0.103	0.122	0.207	0.225
Number Deaths — Hens and Pullets.....	2	0	7	4	18	2	2	1	1	0	3	1	7	1	1	3	1	3	0	7	0	1
Percent Deaths in Flock.....	1.3	0	4.7	2.6	12.8	1.3	1.7	0.6	0.8	0	2.6	0.7	6.3	0.7	1.5	2.5	1.5	2.6	0	6.2	0	1.5
Amount Animal Protein Consumed.....	46	48.6	38	58.5	24	67.8	41.3	85.6	37.0	78.0	42.5	74.8	33.3	74.6	17	45.8	17.8	38.7	11.0	23.0	19.0	3.24

## FINANCIAL STATEMENT

The following is a certified statement of the receipts from the Treasurer of the United States, supplementary funds from the State Department of Agriculture, and sales from the Station farms, with a record of their disbursement:

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,

*In account with the UNITED STATES APPROPRIATION, 1930-31.*

<i>Dr.</i>			
	<i>Hatch Fund</i>	<i>Adams Fund</i>	<i>Purnell Fund</i>
To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June 30, 1931, under acts of Congress, approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund), and February 24, 1925 (Purnell Fund) .....	\$15,000.00	\$15,000.00	\$60,000.00
<i>Cr.</i>			
Salaries .....	\$13,063.00	\$12,820.00	\$42,578.34
Labor .....	351.96	678.57	4,393.17
Stationery and office supplies .....	9.84	-----	268.96
Scientific supplies, consumable .....	210.19	627.19	1,234.87
Feeding stuffs .....	-----	105.06	4,752.68
Sundry supplies .....	136.97	113.12	361.99
Fertilizers .....	39.18	39.55	445.05
Communication service .....	27.18	5.00	148.83
Travel expenses .....	950.69	438.16	2,608.72
Transportation of things .....	24.25	4.84	70.64
Publications .....	-----	-----	1,074.91
Heat, light, water and power .....	-----	31.67	105.06
Furniture, furnishings, fixtures .....	55.00	-----	484.91
Library .....	-----	-----	134.04
Scientific equipment .....	131.74	92.28	161.96
Livestock .....	-----	22.80	423.50
Tools, machinery, and appliances .....	-----	21.76	219.30
Buildings and land .....	-----	-----	100.00
Contingent expenses .....	-----	-----	433.07
Total .....	\$15,000.00	\$15,000.00	\$60,000.00



THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,  
*In account with FARM AND MISCELLANEOUS RECEIPTS.*

*Dr.*

State Department of Agriculture.....	\$60,000.00
Sales .....	13,101.62
Special endowments, industrial fellowships, and similar grants.....	5,520.61
Miscellaneous .....	113.15
	<hr/>
	\$78,735.38

*Cr.*

Salaries .....	\$40,284.76
Labor .....	8,895.03
Stationery and office supplies.....	877.05
Scientific supplies, consumable.....	1,448.87
Feeding stuffs .....	5,086.60
Sundry supplies .....	1,753.69
Fertilizers .....	1,743.77
Communication service .....	871.86
Travel expenses .....	9,732.81
Transportation of things.....	237.35
Publications .....	472.84
Heat, light, water and power.....	1,247.65
Furniture, furnishings and fixtures.....	854.32
Library .....	461.72
Scientific equipment .....	164.13
Livestock .....	663.35
Tools, machinery, and appliances.....	1,655.66
Buildings and land.....	2,181.44
Contingent expenses .....	96.56
Unexpended balance .....	5.82
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	\$78,735.38

We, the undersigned, duly appointed auditors of the expenditures from Federal appropriations reported herein, do hereby certify that we have examined the books and accounts of the North Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1931; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was Nothing on the Hatch Fund, Nothing on the Adams Fund, and Nothing on the Purnell Fund; that the receipts for the year from the Treasurer of the United States were \$15,000.00 under the Act of Congress of March 2, 1887, \$15,000.00 under the Act of Congress of March 16, 1906, and \$60,000.00 under the Act of Congress of February 24, 1925, and the corresponding disbursements \$15,000.00, \$15,000.00 and \$60,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, leaving balances of Nothing, Nothing, and Nothing, respectively.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, March 16, 1906, and February 24, 1925, and in accordance with the terms of said acts, respectively.

(Signed) R. Y. WINTERS,  
*Director of the Experiment Station.*

A. F. BOWEN,  
*Financial Office of the Institution.*

E. C. BROOKS,  
*Comptroller.*

(Seal)

Attest:

A. F. BOWEN,  
*Custodian of the Seal.*



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